Low Emission Urban Delivery Vehicles in South London

Final Report

Prepared for

SOUTH LONDON FREIGHT QUALITY PARTNERSHIP

by:

Transport & Travel Research Ltd

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Consultants' Statement

The views expressed within this report are those presented by stakeholders consulted during the study and of the consultant team, which undertook the project.

These are not necessarily the views of the South London Freight Quality Partnership.

Similarly, the conclusions and recommendations presented within this report are those developed by the consultant project team.

Again, these are not necessarily endorsed by the South London Freight Quality Partnership.

EXECUTIVE SUMMARY

Current EU legislation emphasises the need for continuous improvements in the emissions standards for new vehicles. On average, toxic emissions from the overall vehicle fleet have fallen by between 20% - 50% since 1995, due to successive tightening of emissions standards, which are still working their way through the fleet, as the oldest, most polluting vehicles are replaced. A recent EU directive now requires that government authorities ensure that public transport fleets and other utility vehicles are clean and energy efficient, and MEPs want to make it compulsory that the life-cycle costs for fuel consumption, CO_2 emissions and air pollution be included in any award criteria, rather than just the vehicle purchase price.

Within the UK, the total number of freight vehicles has been increasing since 1997, from a total of 3.2 million up to 4.15 million in 2007. The biggest increase has been amongst the number of light commercial vehicles from 2.6 million in 1997 to 3.5 million in 2007. In 2005, diesel was the most common type of propulsion for Light Commercial Vehicles (LCVs), accounting for 85% of the 3.2 million LCVs.

The Environmentally Enhanced Vehicle (EEV) standard was introduced by the European Union in 1999 to promote the use of the best available environmental technology for sensitive environments. As part of the drive to increase vehicle efficiency and reduce pollution, developments have been made to traditional as well as to alternative fuels and engine technologies that result in lower emissions of pollutants. These technologies include electricity, natural and liquefied petroleum gas, bio-fuels (including biogas) or hydrogen, or which use a hybrid powertrain.

From the review of the available vehicle and fuel technologies, there are considerably more options in existence for smaller freight vehicles, compared to the larger end of the spectrum, and this is encouraging given the changes in freight vehicle numbers since the late 1990s. The review suggests that there is also currently more activity in terms of existing trials for vehicles below 7.5 tonnes GVW than for larger vehicles.

From the public sector fleet experience, budgets are restricted. A number of Boroughs have previously used natural gas and electric vehicles and benefited previously from PowerShift grants in doing so, but experienced multiple problems and have not subsequently continued to use them, whilst commenting that a lack of refuelling infrastructure exists.

The number of vehicles that are directly registered to, or even contracted to the SLFQP Boroughs comprises a relatively small proportion of the total both registered and active within the area. However, the nature of the Borough fleet operations means that in theory they should provide an ideal opportunity for testing emerging technologies. This used to be the case, and many of the SLFQP Boroughs have trialled clean vehicles in the past. However, activity in this area appears to have reduced in recent years, even though most of the Boroughs include aspirational environmental selection criteria. This change can be attributed to two factors in particular:

- The cleanest vehicles tend to cost more to purchase and operate than the conventional alternatives, if for no other reason than production volumes are small meaning that development costs are less well spread per vehicle, and local authority budgets have come under increasing pressure in recent years, meaning that the scope for such trials has diminished, especially as the available grant funding has also largely disappeared.
- Local authority services have increasingly become the subject of stringent service delivery targets, which mean that the risk associated with vehicle trials and a possible reduction in vehicle reliability has led to reluctance to become involved.

One Borough fleet manager also felt that specific requirements within legislation to use such vehicles (such as Low Emission Zones) would also be a driving force behind increasing EEV usage.

In contrast to this it is encouraging to note that in recent years there appears to have been an increased involvement in trials from the private sector, particularly from some national household names. From a financial perspective it is probably easier for these organisations to make the decision to become involved in a trial, although the decision to do so (and particularly and subsequent decision to progress beyond a trial) will be subject to strict commercial considerations.

Looking to the future it is evident that a clear policy steer towards the procurement and use of clean delivery vehicles, preferably accompanied by a financial stimulus, will be essential there is to be a move from limited trials to more widespread use of clean delivery vehicles.

The continual tightening of European vehicle emissions regulations has had and is clearly still having an ongoing impact on the development of both conventional and alternative vehicle and fuel technologies. This development is likely to continue into the future. In many ways it appears that the EEV standard may have served its purpose. Current emissions standards are much tighter than were applicable when the EEV was conceived and specification of forthcoming Euro V and Euro VI, which will be mandatory for all vehicle sizes rather than advisory / aspirational and only applicable to vehicles over 3.5 tonnes, will continue to focus manufacturers attempts towards continuing compliance.

CONTENTS

1 INTRODUCTION & BACKGROUND

This research was commissioned by the South London Freight Quality Partnership (SLFQP), in May 2008.

1.1 The South London Freight Quality Partnership

The aim of the South London Freight Quality Partnership is *"to develop a common understanding of freight transport issues among the membership and promote constructive solutions which reconcile the need for access to goods and services with local environmental, social and safety concerns".*

The Key Stakeholders in the South London Freight Quality Partnership, are local government (eight London Boroughs of Wandsworth, Merton, Sutton, Croydon, Bromley, Lewisham, Richmond upon Thames and Kingston upon Thames), regional government (Transport for London), the Freight Industry (in the first instance represented by the Freight Transport Association and the Road Haulage Association) and local businesses and employers as represented through the Chamber of Commerce and equivalent organisations.

The South London Freight Quality Partnership plan has been developed balancing the national strategy and best practice guidance on Freight Quality Partnerships, with the local context, particularly the London Freight Plan, the Mayor's Spatial Development, Air Quality, Transport and Noise Strategies and the Borough Air Quality Action Plans, to ensure consistency of the proposed approach with the established policy context.

1.2 What is meant by Low Emission Urban Freight Servicing Vehicles?

Current EU legislation emphasises the need for continuous improvements in the emissions standards for new vehicles. On average, toxic emissions from the overall vehicle fleet have fallen by between 20% - 50% since 1995, due to successive tightening of emissions standards, which are still working their way through the fleet, as the oldest, most polluting vehicles are replaced. A recent EU directive now requires that government authorities ensure that public transport fleets and other utility vehicles are clean and energy efficient, and MEPs want to make it compulsory that the life-cycle costs for fuel consumption, CO_2 emissions and air pollution be included in any award criteria, rather than just the vehicle purchase price.

For the purpose of this report we have taken Low Emission Urban Freight Servicing Vehicles to mean Light Goods and Heavy Goods Vehicles which meet the Environmentally Enhanced Vehicle standard (which exceed Euro 5 standards) for emissions of carbon monoxide, methane, non-methane hydrocarbons, particulate matter and oxides of nitrogen. The EEV standard currently only applies to vehicles in excess of 3.5 tonnes gross vehicle weight.

1.3 Project aim and Key project tasks

The key aim of the project was to investigate the potential for Low Emissions Urban Freight Servicing Vehicles in South London. To achieve this, the study also aimed:

- To assess the make up of the SLFQP Borough vehicle fleets to see which emission standards they comply with.
- To investigate whether there are any Urban Delivery vehicles within the Borough vehicle fleets which meet the Enhanced Environmentally Friendly Vehicle standard, in particular those that are powered by electricity, natural and liquefied petroleum gas, bio-fuels (including biogas) or hydrogen, or which use a hybrid powertrain.
- To investigate the extent to which these alternative options are available to Borough fleets.
- To investigate the uptake and experiences of such vehicles by private sector organisations and hauliers which result in reduced local/greenhouse gas emissions.
- To compile a list of some of the vehicles that meet the EEV standard for emissions, in particular those that are powered by electricity, natural and liquefied petroleum gas, bio-fuels (including biogas) or hydrogen, or which use a hybrid powertrain.
- To identify the barriers and drivers to further uptake of alternative fuels and vehicles meeting EEV standards.

2 METHODOLOGY

2.1 Project Management

This study commenced in May 2008 and was finished in March 2009, with project updates being given at the South London Freight Quality Partnership steering group meetings in September and December 2008.

2.2 Work Programme

The study was conducted in three main stages:

- **Initial Desk-based research**

It was initially necessary to carry out desk based research and a literature review of open access material to assess what delivery and servicing vehicles are available in the UK that meet EEV standards. This included any vehicles powered by electricity, natural and liquefied petroleum gas, bio-fuels (including biogas) or hydrogen, or which use a hybrid powertrain. It was also necessary to understand the nature and state of development of the various technologies and fuels, and to investigate Local, National and European policies that are currently in force and affect this issue.

- **Consultation with identified stakeholders and data analysis**

The consultation with the Fleet Managers of the 8 SLFQP Boroughs involved an assessment of the information they supplied about their Borough fleet, based on their answers to the list of questions that is summarised below:

- What is the size and breakdown (e.g. LGV, HGV and if possible payload capacity), of the Borough fleet and to what level of emissions standards do the vehicles conform to e.g. Euro 1-5 and/or EEV (Environmentally Enhanced Vehicle) status?
- Are there any vehicles within the fleet that are hybrids, electric, hydrogen or natural gas powered (Compressed Natural Gas and Liquid Natural Gas)?
- Is there any usage of renewable fuels by the fleet including of biogas or bio-fuels?
- What are their criteria for replacing fleet vehicles and if they are able to source vehicles which meet the EEV standard?
- When considering usage of alternative vehicle and fuel technologies, what do they feel are the main barriers?
- In the future, what influences do they think will be behind any considerations towards using vehicles meeting the Environmentally Enhanced Vehicle Standards?

Consultation also occurred with:

- Private Sector Hauliers
- Private Sector Retailers

- Trade associations of the Road Haulage Association (RHA) and the Freight Transport Association (FTA)
- UK Centre of Excellence for Lower Carbon and Fuel Cell Technologies (CENEX)
- The Energy Savings Trust

Responses to the consultation activity were analysed in detail to identify current fleet structures, key issues, drivers and potential barriers to increasing the number of vehicles used that meet EEV emissions standards.

- **Reporting and recommendations**

Following the analysis phase of the study, recommendations were developed and incorporated in a study report.

3 CONTEXT

3.1 Introduction

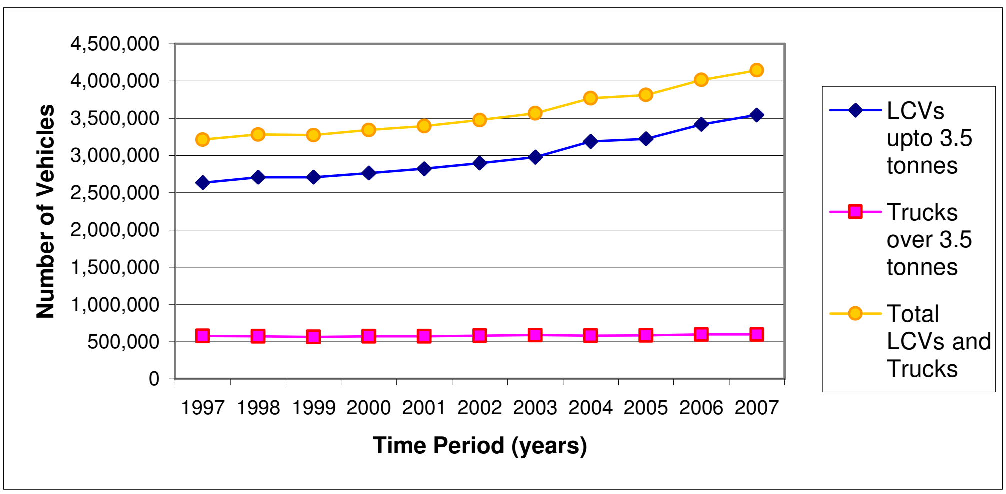
A full policy context is available in Annex A including information on:

- EU vehicle emissions standards, climate change and renewable energy strategies, and the Bio-fuels Directive
- UK climate change policy, research initiatives and demonstration programmes and fiscal incentives
- London air quality and climate change strategies, London congestion charge zone, low emission zone and the London Hydrogen Partnership

3.2 Freight Movements in the UK

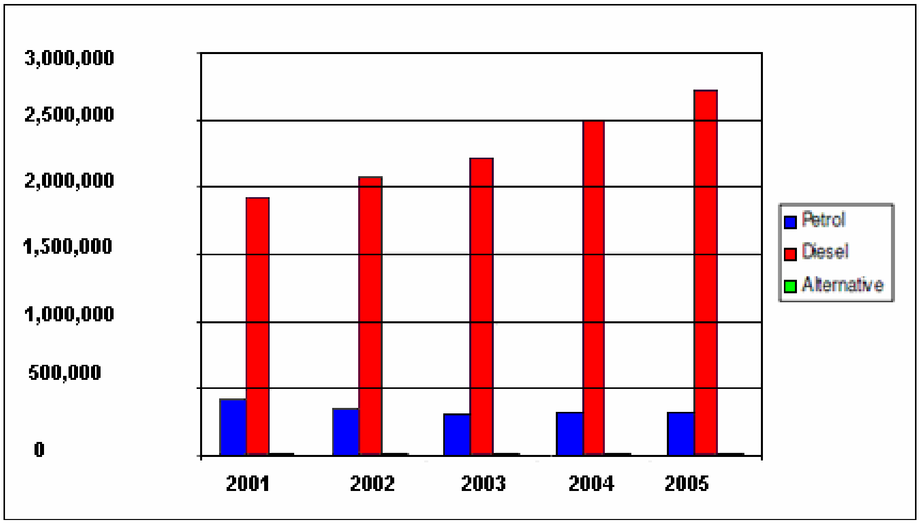
Within the UK, the total number of freight vehicles has been increasing since 1997, from a total of 3.2 million up to 4.15 million in 2007. It is interesting to note that the biggest increase has been amongst the number of light commercial vehicles from 2.6 million in 1997 to 3.5 million in 2007 with the number of trucks over 3.5 tonnes in weight remaining almost constant, (increasing by only 22,000 over the 10 year period, to approximately 598,000 - SMMT, 2008).

Figure 3.1: Freight vehicle trends in the UK (SMMT), 2008



Diesel is used to power the vast majority of trucks over 3.5 tonnes with a study carried out by AEA Momenta in 2006 identifying the propulsion types for light commercial vehicles (LCVs) for the period 2001 – 2005, which is shown in figure 3.2.

Figure 3.2: Total LCV registrations by type (AEA, 2006)



Diesel was the most common type of propulsion for LCVs in the period with diesel accounting for 85% (2.7 million) of the 3.2 million LCVs in 2005, whilst the number of petrol LCVs decreased between 2001 and 2005 by 101,367 to 312,442.

Regarding the numbers of alternatively fuelled LCVs, whilst the AEA report acknowledges that "*the number of alternatively fuelled LCVs has increased from 9,636 to 16,831 LCVs (an increase of 75%), the pattern of new registrations for alternative fuels shows a different picture however, with registrations increasing by 170% from 1,160 (2001) to 3,136 (2003) and then subsequently decreasing by 50% from 3,136 (2003) to 1,586 in 2005. It would appear that UK Government and local Government policy as well as operational needs could influence the alternative fuelled market. For example, the London congestion charge and Energy Saving Trust grant programmes may have contributed to the increase in alternative fuelled LCVs in the UK up to 2003. However, many operators have found that the use of alternative fuels such as Liquefied Petroleum Gas (LPG) and Compressed Natural Gas (CNG) has a number of difficulties, including loss of load space, reduced fuel economy and limited refuelling infrastructure. In addition these alternative fuels have faced competition from more efficient diesel engines, which may also be the reason for the decrease in registrations from 2003 onwards*" (AEA, 2006).

3.3 South London

Of all the freight transported in London, the majority (88%) is carried by road, with LGVs and HGVs responsible for 5% and 12% respectively, of the total vehicle kilometres travelled by motorised road vehicles in 2005.

Table 3.1: Freight lifted by mode in London, 2005 (TfL[3], 2008)

MODE	Million Tonnes	Percent
Road	137.0	88.0%
Rail	7.8	5.0%
Water (Thames inside London)	8.7	5.6%
Water (Other waterways in London)	0.3	0.2%
Air	1.9	1.2%

There are approximately 238,000 goods vehicles licensed to addresses within the London Boroughs, with the majority of these, 90%, being light goods vehicles up to 3.5 tonnes gross vehicle weight, and 9% being rigid goods vehicles over 3.5 tonnes gross vehicle weight. Only 1% of vehicles are articulated goods vehicles. This information is shown in table 3.2 and for the relevant SLFQP member Boroughs in table 3.3.

Table 3.2: Goods vehicles licensed with keepers' addresses in London, 2006 (TfL[3], 2008)

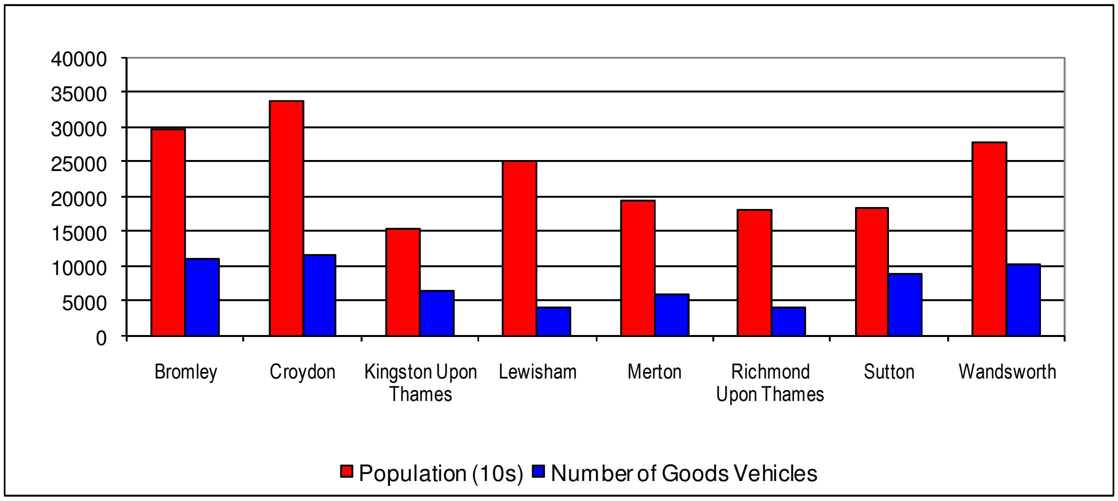
Vehicle Type	Number of Licensed Vehicles
Light Goods Vehicles up to 3.5 tonnes gvw	213,671
Rigid Goods Vehicles over 3.5 tonnes gvw	21,317
Articulated Goods Vehicles over 3.5 tonnes gvw	2,996
Total	**237,984**

Table 3.3: Goods vehicles licensed with keepers' addresses in London boroughs, 2006 (TfL[3], 2008)

Borough	LGVs	Rigid Goods Vehicles	Articulated Vehicles	Total Goods Vehicles
Bromley	10,602	521	82	11 205
Croydon	10,830	680	33	11,543
Kingston Upon Thames	3,944	115	13	4,072
Lewisham	6,031	518	48	6,597
Merton	5,394	580	41	6,015
Richmond Upon Thames	3,874	148	13	4,035
Sutton	8,045	644	144	8,833
Wandsworth	9,795	554	10	10,359
TOTAL	**58,515**	**3,760**	**384**	**62,659**

The breakdown of the number of goods vehicles registered to residents' addresses in the South London Boroughs is similar to that of London as a whole, but with a larger proportion of light good vehicles up to 3.5 tonnes (gross vehicle weight) at 93%. In the SLFQP Boroughs, there are approximately 1.9 million people, with the largest Boroughs by population being Wandsworth, Croydon, Bromley and Lewisham. Unsurprisingly, the 3 Boroughs which have the largest populations also have the largest number of licensed goods vehicles, with Kingston and Richmond, the Boroughs with the smallest populations, having the lowest number of licensed goods vehicles (figure 3.3).

Figure 3.3: Population and number of goods vehicles for the South London Boroughs



There are different uses for LGVs and HGVs in London. Table 3.8 shows the proportion of vehicle kilometres used by LGVs by business sector within London, and table 3.9 shows the commodities lifted by HGVs within London, proportionally by weight:

The data in table 3.4 is for company vehicles only and are the results from the Department for Transport study into company van activity in 2005. The business sectors that make up the highest percentage of kilometres travelled by LGV within London are construction (31%), Wholesale and Retail Trade, Repairs and Hotels (23%) and Transport, Storage and Communication (18%).

Table 3.4: Vehicle kilometres performed by LGVs to, from and within London by business sector, 2005 (million vehicle kilometres and proportions) (TfL[3], 2008)

Proportion of Vehicles Kilometres used by LGVs						
Business	**Within London**		**To London**		**From London**	
	Km	%	Km	%	Km	%
Agriculture, forestry and fishing	83	4	5	1	6	1
Energy and Water Supply	65	3	13	2	7	1
Manufacture, mining and quarrying	192	10	102	11	122	15
Construction	610	31	396	47	365	45
Wholesale and Retail Trade, Repairs and Hotels	439	23	180	22	185	23
Transport, storage and communication	342	18	47	6	51	6
Banking, finance and insurance, business services and leasing	105	5	72	9	61	7
Education, public admin & defence, extraterritorial organisations	13	1	-	-	-	-
Health, social work and other community services	90	5	21	2	16	2
Totals	**1939**	**100**	**836**	**100**	**813**	**100**

Table 3.5: Goods lifted by HGVs on journeys to, from and within London by commodity category, 2005 (proportion by weight) (TfL[3], 2008)

Commodity	**Proportion Lifted Within London**	**Proportion to London**	**Proportion from London**	**All Goods lifted with Origin and/or Destination in London**
Food, drink and tobacco products	11%	28	17	18
Bulk products inc. sand and cement	48%	28	25	35
Chemicals, petrol and fertilisers	2%	8	4	5
Miscellaneous products	40%	36	54	42
Totals	100	100	100	100

Construction materials also account for the largest percentages of goods by weight lifted by HGV within London with Bulk Products including sand and cement making up 48%, with miscellaneous products second largest, with 40% by weight. This is in contrast to good transported to and from London, where miscellaneous products account for the largest proportion by weight. For goods transported to London, food, drink and tobacco products, and bulk products including sand and cement both accounting for 28% of goods by weight, whilst for goods originating from London, bulk products are the second largest by weight with 25%.

4 VEHICLE TECHNOLOGIES AVAILABLE

4.1 Introduction

The Environmentally Enhanced Vehicle standard was introduced by the European Union in 1999 to promote the use of the best available environmental technology for sensitive environments. As part of the drive to increase vehicle efficiency and reduce pollution, developments have been made to traditional as well as to alternative fuels and engine technologies that result in lower emissions of pollutants. These technologies include electricity, natural and liquefied petroleum gas, bio-fuels (including biogas) or hydrogen, or which use a hybrid powertrain.

4.2 Diesel Engines

At present, vehicle manufacturers are able to use end of pipe solutions to minimize toxic emissions (NO_2, PM_{10}) from diesel engines and, depending on the combination of emissions abatement and engine technologies, they may be able to meet the EEV emissions standards. These solutions typically involve exhaust and emission control systems, and can include the use Oxidation Catalysts, Particulate Traps, Selective Catalytic Reduction and Exhaust Gas Re-circulation.

Oxidation Catalysts

Oxidation catalysts consist of a stainless steel canister containing a honeycomb structure which is coated in precious metals. The metals are catalysts that chemically react with exhaust pollutants of carbon monoxide and hydrocarbons, turning them into carbon dioxide, water and soot respectively. They are currently fitted as standard into vans and light duty trucks, and can be retro-fitted to older vehicles (Transport Energy, 2003). They are also beneficial for heavy duty vehicles with emissions reductions for hydrocarbons and carbon monoxide of up to 90%, and particulate matter between 20 – 50% (SeaRenue, 2007).

Particulate Traps

Particulate traps use a filter fitted to the exhaust pipe, and can be fitted to heavy duty vehicles, taxis and vans, with emissions reductions for particulate matter of up to 95%. Particulate traps can also be fitted with additional catalysts, which can reduce carbon monoxide and hydrocarbons by up to 80%.

Selective Catalytic Reduction

Selective Catalytic Reduction (SCR) involves injecting a reducing agent such as urea or ammonia into the exhaust gas to reduce emissions of the oxides of nitrogen. In a similar way to particulate traps, SCR technology can be applied on its own, or in co-ordination with an oxidation catalyst or particulate trap. The Transport Energy Paper "Reducing Emissions from Diesel Vehicles" suggests that the use of SCR can reduce nitrous oxide emissions by between 30 and 70% depending on the duty cycle, as the process is temperature dependent.

As an example, DAF currently use this technology, after introducing it in 2007, in conjunction with their PACCAR heavy duty engines. These use an advanced high-pressure fuel-injection system, which without a passive soot filter conforms to Euro 5 standards. However, through the fitting of a passive soot filter, a further 50% reduction of particulate emissions can be achieved, resulting in 0.015 grams/kWh which is 25 percent lower than the EEV standard. The 9.2 litre PACCAR EEV engine emits 2 grams of NOx, 0.05 grams of CO and 0.1 grams of hydrocarbons per kW/h, and almost negligible emissions of visible smoke. DAF also introduced the 12.9 litre PACCAR MX engine with passive soot filter, which is also EEV compliant (DAF, 2007). In addition to DAF, Volvo, Mercedes-Benz, IVECO, Renault and Scania also use SCR technology to reduce the exhaust emissions from their engines.

Exhaust Gas Recirculation

An alternative to SCR for the reduction of NOx emissions is exhaust gas recirculation (EGR) which, as the name suggests, involves intercepting the exhaust gases and reinjecting a controlled portion back into the combustion chamber. EGR is available both as a retrofit option and is used by some manufacturers on new vehicles.

4.3 Bio-fuels

4.3.1 Bio-diesel

Biodiesel is produced from biomass (the oil of crops such as rapeseed) or from recycled waste cooking oil. Biodiesel can be blended with conventional diesel in various proportions. Vehicles can be refuelled in the same way as conventional diesel vehicles and therefore no major new infrastructure is required, although care is required during storage of the fuel to prevent water absorption.

Diesel containing 5% biodiesel (B5) is widely available and can generally be used in the same way as conventional diesel. Higher blends are available to varying specifications (e.g. B10, 20, 30 and B100). Their suitability for use depends on the vehicle specification and the blend limit which the vehicle manufacturer has defined as acceptable.

Life cycle CO_2 emissions vary depending on the source of the biodiesel. If land use change is not considered and assuming today's production methods, biodiesel from rapeseed and sunflower oil produce 45%-65% lower greenhouse gas emissions than conventional diesel. However, there is ongoing research to improve the efficiency of the production process. Biodiesel produced from used cooking oil or other waste fat could reduce CO_2 emissions by as much as 85%, and would have better sustainability credentials. Toxic emissions (NO_2, PM_{10}) are broadly the same as for conventional diesel. A 2002 EPA summary analysis of existing data suggests vehicles using biodiesel may emit slightly more nitrogen oxide (NO_x) (about 2% for B20 and 10% for B100). Subsequent studies have yielded mixed results, with some showing small increases and others showing small decreases.

There are some specific issues over using higher blends of biodiesel that are of concern to vehicle manufacturers:

- High viscosity stresses the high pressure fuel pump
- Oxidation degradation with time
- Moisture Content can lead to growth of micro-organisms
- Solvency of Biodiesel on seals
- Cylinder combustion due to peak hydrocarbon distribution

Biodiesel has been known to break down deposits of residue in the fuel lines where petro-diesel has been used. As a result, fuel filters may become clogged with particulates if a quick transition to pure biodiesel is made.

The specific properties of biodiesel mean vehicle manufacturers are careful to state what blends can be used without invalidating vehicle warranties. Ensuring fuel quality and meeting any required certification levels is therefore important

At the time of writing Morrisons has been supplying B30 biodiesel via selected forecourts to support a trial with BSkyB-operated Vauxhall vans. Much work has been done on the blending process behind this fuel to obtain the best performance.

Table 4.1: Type of bio-diesel and greenhouse gas savings (DBERR, 2008[7])

Biodiesel Fuel	GHG Savings
Palm Oil Biodiesel	16 – 57%
Hydrogenated Vegetable Oil	24 – 83%
Rape Seed Biodiesel	36 – 44%
Sunflower Biodiesel	51 – 58%
Pure vegetable Oil from rape seed	55 – 57%
Waste Animal or Vegetable Oil Biodiesel	77 – 83%
Bio-methane	75 – 88%

However, there has been and continues to be a large amount of debate surrounding the sustainability, potential greenhouse gas savings and other impacts associated with growing bio-fuels, and in July 2008, the Renewable Fuels Agency published “The Gallagher Review of the indirect effects of Bio-fuel Production”, commissioned as a result of uncertainties surrounding the un-intended side-effects of bio-fuels. It found that by 2020 "bio-fuels will have the potential to deliver annual global greenhouse gas savings of approximately 338 to 371 million tonnes of carbon dioxide". However, the report also concluded that there is a risk that the uncontrolled expansion and use of bio-fuels could lead to unsustainable changes in land use - such as the destruction of rainforest to make way for the production of crops (table 4.2). This might, in turn, actually increase greenhouse gas emissions as well as contributing to higher food prices and shortages (Renewable Fuels Agency, 2008). Following on from a recommendation in the report, the UK government announced that the introduction of bio-fuels is to be slowed to 5% by 2014, and that this would allow time for more sustainable bio-fuel technologies to emerge (DfT, 2008[9]).

Table 4.2: Illustrative greenhouse gas savings and payback times for bio-fuel feedstock causing land use change (Renewable Fuels Agency, 2008)

Fuel Chain	Assumed County of Origin	GHG Saving excluding the impacts of land use change	Carbon Payback (year)	
		%	Grassland	Forest
Palm to Biodiesel	Malaysia	46%	0 – 11	18 – 36
Soya to Biodiesel	USA	33%	14 – 96	179 – 481
Sugarcane to Bio-ethanol	Brazil	71%	3 – 10	15 – 39
Wheat to Bio-ethanol	UK	28%	20 – 34	80 - 140

Unlike with some alternative fuels, bio-diesel can be used in existing infrastructure for fuel storage and delivery and can be used in existing diesel engines without any modification to the engine. In addition, vehicles prepared for bio-diesel can also run on standard diesel if necessary (EU, PROCURA, 2007).

4.3.2 Bio-diesel from Used Cooking Oil

In addition to producing bio-diesel through the use of vegetable oil derived from biomass, used cooking oils (UCO) can also be used to make bio-diesel. The UK Renewable Fuels Energy Strategy (2008) states that carbon dioxide savings from the use of bio-diesel produced from UCO can be in the region of 77 – 83%, whilst the SWELTRAC (2007) Study on the Provision of Bio-diesel to the Local Authority Members of SWELTRAC's main recommendation was that Local Authorities should source biodiesel made from UCO for their fleets. The cost of the fuel was generally expected to be cheaper than the diesel alternative.

In the wake of the problems with the proposed BISTRO project in 2007[1], SWELTRAC felt that in the future, and in order for fleet managers to develop confidence in using bio-diesel, "that it would be better for a local authority to work in partnership with a social enterprise or private company who can take the financial and reputational risk and who are equipped with the expertise needed to run a successful production plant and to produce high quality biodiesel certified to European standards. Costs are difficult to ascertain and can rise due to unforeseen events thus it is important to allow a good contingency fund. It was also felt that it would be sensible to conduct a successful trial prior to commencing production of UCO derived bio-diesel to ascertain the market".

The SWELTRAC study report notes that demand for bio-diesel in the UK currently outstrips supply and that even maximising production, by 2020, the UK will only be

[1] The aim of the BISTRO project, developed by SELTRANS and led by the London Borough of Bromley, was to build a 1 million litres per annum biodiesel production plant using Used Cooking Oil collected in the South London as the feedstock. This would have been used to supply part of the fuel demand from the associated boroughs' vehicle fleets However, in mid 2007 the London Borough of Bromley withdrew the borough site from the project due to possible financial risk, after the costs of UCO collection, biodiesel distribution and construction of the building to house the plant turned out to be greater than originally anticipated (SeaRenue, 2007).

able to supply 20% of the transport fuel needs through bio-diesel, with a further 1% from waste products such as used cooking oil (SeaRenue, 2007).

4.3.3 Bio-ethanol

Bio-ethanol is a petrol substitute which is made from the fermentation and distillation of agricultural raw materials which are high in sugar and starch content, such as sugar beet, cereals including cassava and corn, potatoes and fruit. As in the case of bio-diesel, there are reductions in the amounts of carbon monoxide and particulate matter, but emissions of NOx may increase (SeaRenue, 2007).

Bio-ethanol can be used in petrol and spark ignitions engines in an anhydrous (water free) state, which can consist of any blend of ethanol and petrol, with little or no modification at percentage blends of around 10%, although as with bio-diesel, vehicle manufacturers' warranties are often set at up to 10% bio-ethanol at present. For higher blends, modifications are needed or dedicated or flexi fuel vehicles (FFVs) must be used, which can use any mixture from pure petrol to E85 (85% ethanol / 15% petrol).

Bio-ethanol is not well developed in the UK in comparison to some other countries such as Sweden. Morrisons has been trialling supply of ethanol blend at a small number of filling stations across the UK and, as part of the EC-sponsored BEST project a trial has been taking place in Somerset involving operation in a number of Ford Focuses.

From a transferability perspective, the majority of local authority commercial fleet vehicles are fuelled by diesel, and so bio-ethanol usage would not be applicable.

4.4 Natural Gas

Natural gas is a gaseous fossil fuel composed of about 90% Methane (CH_4), with the remainder comprising of propane, butane, and other components, depending on the source of the gas (EU Alternative Fuels Contact Group, 2003[11]).

Table 4.3: Sources of natural gas (Clean Air Power, 2007)

Natural Sources	Human Sources
Wetlands	Fossil Fuels
Geological Sources	Livestock
Insect Activity	Wastewater Treatment
Oceans	Landfill
Tundra (Climatic Thawing)	Wet Crops

Natural gas can be used as a road transport fuel in 2 main forms – the most common of which is compressed (CNG) or liquefied (LNG) form. In each case, the gas is stored on board the vehicle in cylinders and piped to the combustion chamber of the engine at the appropriate pressure, and is ignited to create the power to drive the vehicle. There are generally 3 types of natural gas powered vehicles:

- **Spark Ignition** engines are associated with re-engineered variants of standard diesel power units, adapted to allow for spark ignition. They only run on natural gas and can suffer from a reduced range, compared to the diesel variant, and as a result are limited to local distribution activities (Clean Air Power, 2007).

- **Bi Fuel** vehicles operate on natural gas whilst retaining the ability to use petrol as a fuel reserve, but can not run on both fuels simultaneously. Currently this type of engine is used almost exclusively on vehicles below 3,500kgs.

- **Dual Fuel** engines are derived from diesel engines retaining a small amount of diesel as the pilot source of ignition. This type of engine does not require spark plugs with the natural gas being mixed with incoming air and auto ignited by compression.

Whilst it is acknowledged that there are additional costs associated with purchasing natural gas vehicles, there can be economic benefits from using natural gas over petrol and diesel, as a result of lower prices for fuel (table 4.4).

Table 4.4: Fuel costs comparison (NSCA, 2006)

Vehicle Type	Km/year	Fuel	Fuel Consumption		Fuel Price (exc. VAT)		Fuel Cost	
			l/100km	Kg/100km	Diesel	CNG	p/km	£/year
Light Goods	29,000	Petrol	9.4		0.73		6.9	2001.57
		ULSD	7.1		0.77		5.45	1579.77
		CNG		6.2		0.55	3.41	988.9
Heavy Goods	95,000	ULSD	37.6		0.77		28.85	27406.17
		CNG SI		34.65		0.55	19.06	18104.63
		CNG DUAL	3.17	25.38	0.77	0.55	16.39	15571.62
Note: Diesel and petrol prices from DTI retail costs data, CNG prices from operator information to study.								

Taking into account the additional capital and maintenance costs involved in purchasing and operating the vehicles, there can be economic savings from using natural gas as the fuel type for heavy duty vehicles, depending on the operational profile, as shown in table 4.5 and 4.6.

Table 4.5: Additional capital and maintenance costs for compressed natural gas vehicles (NSCA, 2006)

Vehicle	Km/year	Capital (£)			Maintenance	Total	
		Total	Per Year	Per Km		p/km	£/Year
Van	29,000	5000	1,250	0.04	0.01	5.31	1540
HGV SI	95,000	30000	7,500	0.08	0.01	8.89	8450
HGV Dual Fuel	95,000	20000	5000	0.05	0.01	6.26	5950

Table 4.6: Total fuel and additional operating costs for light and heavy goods vehicles (NSCA, 2006)

Vehicle Type	Km/year	Fuel	Costs	
			p/km	£/year
Light Goods	29,000	Petrol	6.9	2001.57
		ULSD	5.45	1579.77
		CNG	8.72	2528.92
Heavy Goods	95,000	ULSD	28.85	27406.17
		CNG SI	27.95	26554.63
		CNG DUAL	22.65	21521.62

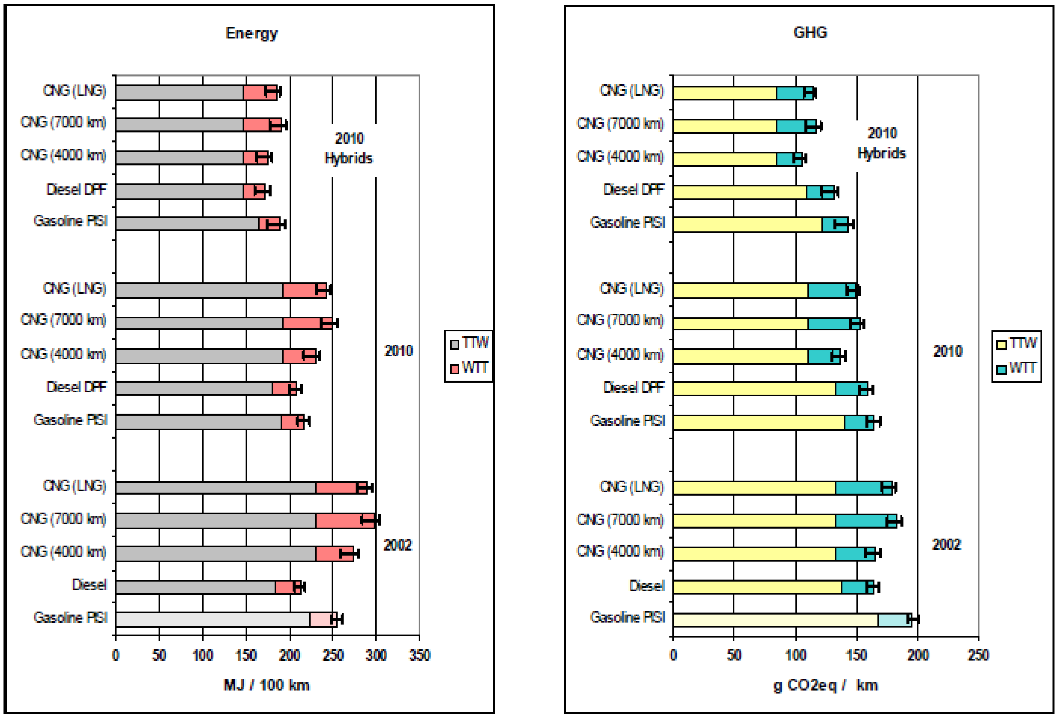
In addition to fuel and operating cost benefits, there are environmental benefits from using natural gas vehicles over diesel or liquid petroleum gas (LPG), with significantly lower emissions of particulates, hydrocarbons, nitrous oxide and carbon monoxide (table 4.7). Natural gas powered vehicles also have lower levels of noise associated with their movements (Bestufs, 2005), which provides an additional advantage for delivery vehicles that require access late at night and in the early morning.

Table 4.7: Emissions reductions from natural gas vehicles compared to diesel engines (Clean Air Power, 2007)

Emission	Reduction
Carbon Dioxide	10%
Carbon Monoxide	70%
Nitrogen Oxide	80%
Hydrocarbon	80%
Benzene	97%
Particulates	100%
Sulphur	Almost 100%

In terms of reducing carbon dioxide emissions, in the 2003 EU Alternative Fuels Contact Group report “Market Development of Alternative Fuels”, it was claimed that for marginal natural gas supplies within 4000 km distance, natural gas vehicles have a clear CO_2 advantage over petrol and are comparable to diesel vehicles (figure 4.1). In the future, the Wheel to Wheel GHG balance of CNG is expected to become more favourable than that of diesel by about 13% for the 4000 km case. Further possible technological developments have the potential of additional future CO_2 reductions arising from the use of natural gas fuelled vehicles.

Figure 4.1: Energy efficiency and greenhouse gas comparison of diesel, gasoline (petrol) and compressed natural gas (EU Alternative Fuels Contact Group, 2003)



As well as dedicated natural gas vehicle manufacturers, there are a number of suppliers of natural gas systems which can be **retrofitted** to existing vehicles, or incorporated into the design of any vehicle.

One of these is Clean Air Power, who has developed a Dual Fuel System (called Genesis), which enables heavy duty diesel engines to operate primarily on natural gas, with diesel fuel acting as a liquid spark plug. The engine can also operate on bio-methane and bio-diesel, potentially making the vehicle carbon neutral. The system can be either integrated working hand in hand with the manufacturers' technology, or retrofitted to most commercial diesel engines. The annual savings of the system, according to Clean Air Power are 55% natural gas substitution, 27 tonnes of Carbon Dioxide a year, and a cost saving of 6p/km per vehicle, based on an HGV with a mileage of 200,000 km a year. .

For further information see www.ngva.co.uk

Natural gas powered vehicles have been in use in the UK since the early 1990s with British Gas being one of the first companies to trial the vehicles. However, despite support through fiscal incentives, the number of vehicles and associated infrastructure in the UK remains markedly low compared with many other countries (table 4.8).

Figure 4.8: The number of natural gas vehicles around the world, in 2005 (Petroleum Review 2006)

Country	Number of Natural Gas Vehicles
Argentina	1,439,527
Brazil	1,000,424
Pakistan	800,000
Italy	382,000
India	204,000
US	130,000
China	97,200
Ukraine	67,000
Egypt	62,150
Colombia	60,000
Iran	48,029
Venezuela	44,146
Russia	41,780
Germany	27,200
Japan	24,684
Canada	20,505
Sweden	7,000
UK	543
Others	200,000
Total	**4,706,000**

As shown, there were approximately 550 natural gas vehicles in operation in 2005, although by 2006 this had fallen to 508 according to the National Society for Clean Air. Of these 508, 44 were cars, 38 were vans, 110 were HGVs less than 7.5 tonnes, and 316 were HGVs greater than 7.5 tonnes.

4.5 Biogas

Biomethane is chemically very similar to natural gas, and therefore can be used as a substitute energy carrier. The use of biomethane in vehicles has many of the same benefits, and barriers, as using natural gas.

Biogas is produced from the decomposition of organic matter, and can be produced from a number of waste sources such as sewage, animal slurry, municipal waste and food waste using anaerobic digestion (AD). Biogas can be processed into bio-methane and then used in vehicles in the same way as natural gas, as they have the same main chemical component (CH_4).

A major benefit over natural gas, and other fuels, is that bio-methane is a renewable fuel and therefore the life cycle carbon emissions are significantly lower for bio-methane than for natural gas. Using bio-methane in vehicles can give a reduction in life-cycle CO_2 emissions of around 80-90% compared to conventional diesel. There is currently renewed interest in methane from renewable sources as a transport fuel, and in increasing the amount of AD generally in the UK to capture more of this renewal energy source. Bio-methane fits with the recommendations of the Gallagher Review, which proposes that biofuel production must be focused on idle and marginal land and increasingly use wastes and residues. The sustainability credentials of bio-methane are extremely good.

According to an NSCA report, biogas fuelled vehicles can reduce CO_2 emissions by up to 200% compared with fossil fuels using liquid manure as a feedstock. This showed a negative carbon dioxide contribution arising because liquid manure left untreated generates methane emissions, which are 21 times more powerful as a greenhouse gas than CO_2. Therefore, there is a double benefit by reducing greenhouse gas emissions from burning diesel and reducing methane emissions from waste manure (figures 4.2 and 4.3).

The fuel costs are dependent on the production and distribution methods with prices often mirroring natural gas prices, which are generally lower than diesel, so offsetting some of the extra capital costs.

There are a number of examples in Europe of bio-methane powered vehicles, as commented in the EU Alternative Fuels Report, “Market Development of Alternative Fuels”. As of 2003, over 4000 vehicles were in operation in Sweden that were fuelled by bio-methane, and in Lille, France, 127 of the region’s bus fleet are run on bio-methane. This proves the reliability and cost-effectiveness of bio-methane and Lille has the aim of having all of their bus fleet fuelled by bio-methane by 2011.

Figure 4.2: GHG emissions for a 2002 European class weighted average light goods vehicle (NSCA, 2006)

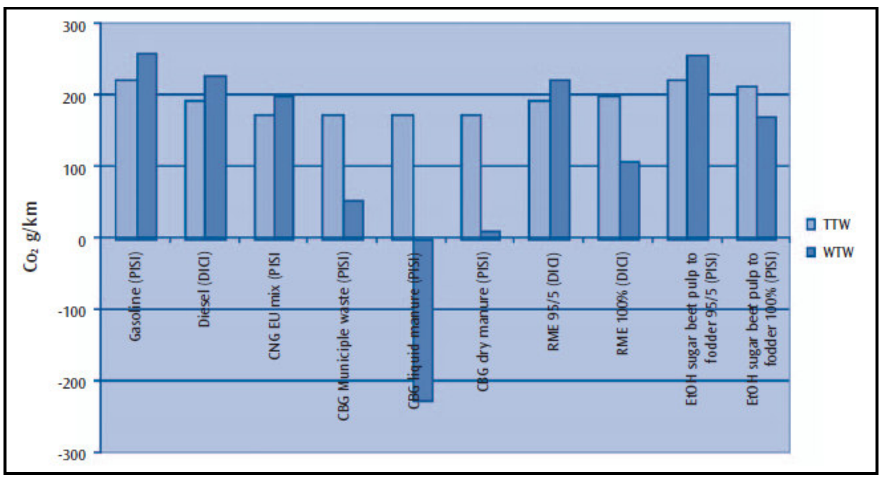
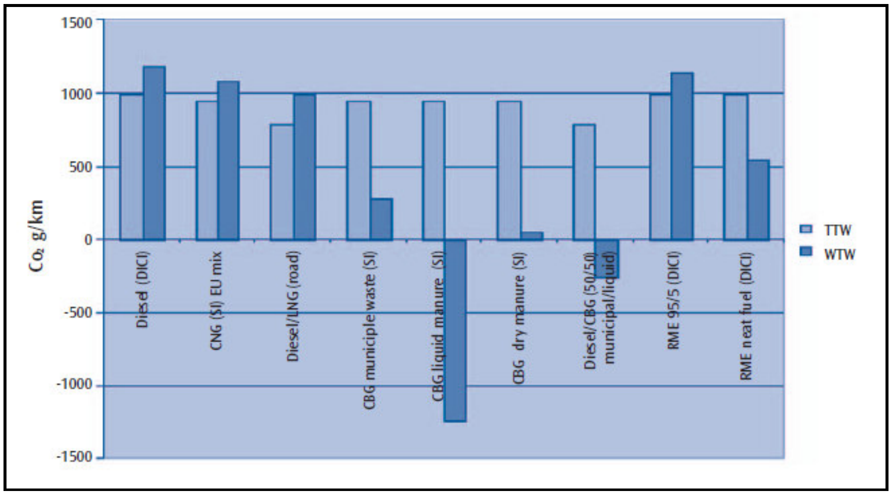
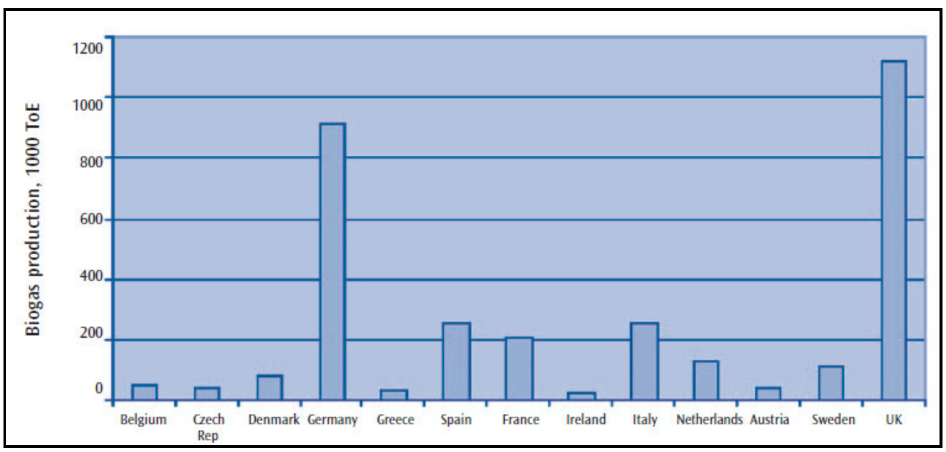


Figure 4.3: GHG emissions for a 2002 Generic 38t Truck (NSCA, 2006)



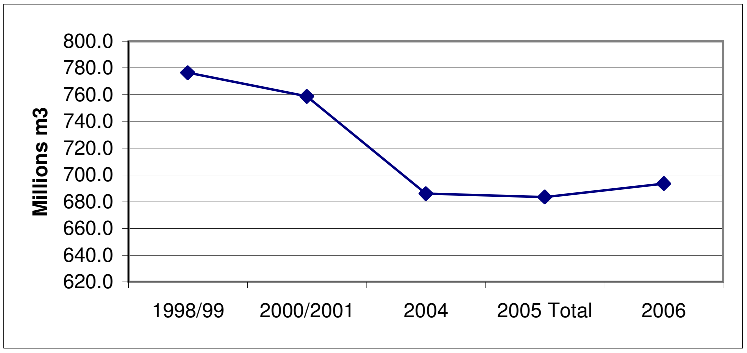
The NSCA report indicated that there is a large potential for biogas in the UK and that if all of the gas produced by anaerobic digestion was collected, processed and used as a transport fuel the total gas volume produced would amount to 7.4 billion cubic metres of methane. This is equivalent to some 263,000 TJ of energy or 6.3 million tonnes of oil equivalent. If all of this energy were used for transport it would replace around 16% of our current road transport fuel demand.

Figure 4.4: Biogas production across Europe (NSCA, 2006)



At present, the main sources of biogas are from sewage and landfill sites and approximately 75% of all biogas arises from these sources. The UK collects the largest amount of biogas in Europe, and the proportion collected from landfill sites, compared to other sources has been increasing in the past few years. As such, there is limited potential to expand collection of biogas from these sources in the UK. Furthermore, there may be impacts from the EU Landfill Directive which requires EC Member States to reduce the amount of municipal biodegradable waste being sent to landfill, which will result in less feedstock to produce biogas. Available landfill capacity in the UK is also decreasing (figure 4.5). However, this can be addressed by the use of purpose built anaerobic digesters with specifically collected waste streams.

Figure 4.5: UK landfill capacity (Environment Agency, 2006)



Whilst the UK collects 75% of its biogas from landfill sources, it is currently used for electricity and heat production. This is due to the fiscal incentives in place encouraging the use of biogas for these purposes. However, this process can be inefficient if there is no demand locally for the heat generated. In addition to converting the bio-methane to electricity, transmitting it through the national grid incurs further transmission losses, increasing the inefficiency of the use of biogas in this way.

In the UK, the same technical barriers exist for using bio-methane as a road fuel as for natural gas, namely the availability of vehicles and a dedicated refueling infrastructure. Additionally there have been issues around the location of biogas production in relation to use. However, it was announced on the 30th October 2008 that the UK government had included a clause in the most recent Energy Bill which, would enable renewable methane to be injected into the local gas grid, and an equivalent amount of energy taken out anywhere in the UK and used in high efficiency uses. With this new law, the natural gas can be piped to where it is needed and used more efficiently. It will also assist users of natural gas fuelled vehicles, which can run off bio-methane including supermarket and utility commercial vehicles, which are identified in table 5.4 (CNG Services, 2008).

4.6 Electricity

Similarly to gas powered vehicles, there are a number of variations on the energy storage and delivery systems used within electric delivery vehicles:

- **Battery Powered** – these are powered only by electricity provided by a battery. The battery can only be charged from the mains, and these vehicles typically have low operational ranges.
- **Hybrids** – these vehicles have both an electric motor and a diesel engine, and can also a feature stop and start function. The electric motor is typically used at low speed and is thus ideal for urban driving, and charged through the engine and/or a process known as Regenerative Breaking, whereby some of the kinetic energy generated during braking is fed back into the system. The stop start function enables the engine to stop when the vehicle

stops, which can save carbon dioxide emissions in the region of 10 – 25% alone.

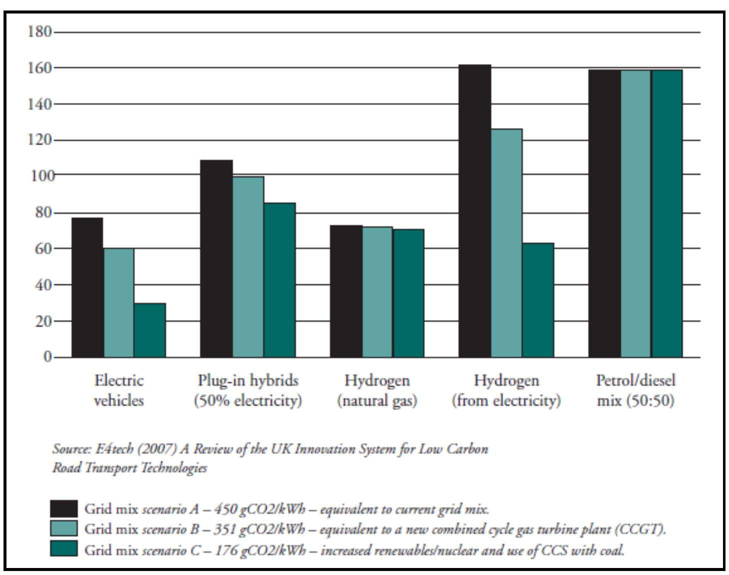
- **Plug In Electric Hybrids** – these are similar to the hybrids, but have an additional battery pack included that can be recharged from mains electricity points, in addition to being topped up by the engine like the existing battery pack (Ecolane, 2006). This allows for a longer electric only driving range and is currently being developed for the Toyota Prius.

In addition to the low cost of fuel which is typically in the region of £0.01/mile, there are no emissions at the point of use and as such there is no significant effect on local air quality. As in the case of natural gas powered vehicles, there are lower levels of noise associated with electric delivery vehicles, which makes them ideal for use in the early hours or late at night.

However, the vehicles are typically more expensive than diesel variants, with the batteries expensive to replace, although some companies offer the batteries on a lease agreement. Furthermore, unlike with diesel, biodiesel or gas powered vehicles, battery powered and plug in hybrids have longer refuelling times as a result of the need to recharge the battery (SeaRenue, 2007). For this reason, it is common for many companies and operators to re-charge their vehicles overnight in depots.

However, from a life cycle analysis perspective, despite there being no emissions at the point of use, there can be carbon emissions associated with the use of electric vehicles depending on how electricity is produced. This point is referenced in the King Report, commissioned by HM Treasury and is shown in figure 4.6.

Figure 4.6: CO_2 emissions from electricity and hydrogen under different grid mix scenarios (gCO_2 /km)



However, even with current electricity grid mix, the UK Renewable Energy Strategy (2008) comments that, "all-electric vehicle CO_2 emissions have been estimated at around 77g/CO_2/km based on recharging from today's grid mix (compared to a 2007 new car CO_2 average of 167g/CO_2/km)". At present, data is only available on the total number of electrically powered cars within the UK, not delivery vehicles or trucks.

There have been a number of electrically- powered delivery and commercial vehicles in operation in the UK for a number of years including 16,000 milk floats, and in a number of specialist applications such as forklifts and for airport operational needs. A number of types of light van have been available since the late 1990s, including the Citroen Berlingo, Peugeot Partner (Ecolane, 2006) and Renault Electro'Road. The Electro'Road was a plug in hybrid version of the electric Kangoo, but did not sell well and was discontinued in 2007. Since then, there have been a number of developments which have seen a number of electric delivery vehicles being sold in larger numbers and getting a large amount of positive media coverage, with a large number of vehicles currently in the trial and demonstration phases (see section 5.1).

Similarly to natural gas systems, retrofits can be applied to diesel engines to allow the delivery vehicles to become diesel-electric hybrids. One such system has been developed by Connaught, which utilizes compact super capacitors and the principle of regenerative braking allowing the capacitors to recharge using the power generated during braking. The system enables lower fuel costs (with a 15-25% saving) and reduced carbon emissions (15 – 25% saving) over the vehicles life time. (Green Car Site, 2007)

4.7 Hydrogen

" Almost complete de-carbonisation of road transport could be possible by 2050, most likely through electric or hydrogen-powered vehicles." The King Review of Low Carbon Cars, 2007

Hydrogen is the least commercially developed alternative fuel at present, despite there being a large amount of research being conducted into it for many years. Hydrogen can be used to power vehicles by either being burnt in an internal combustion engine, or by generating electricity in a fuel cell. In a fuel cell, hydrogen (or a hydrogen-rich fuel) is chemically converted into water, electricity and heat. Similarly, when hydrogen is burnt in or reacted with oxygen, the only by-product is water, typically in the form of steam. Therefore, like electricity, hydrogen offers the potential advantage that it creates no harmful emissions at the point of use and its life-cycle CO_2 emissions are largely determined by how it is sourced (figure 4.6) (HM Treasury, 2007).

Hydrogen powered vehicles, of all scales, are currently at the prototype stage of development, with a number of demonstration models anticipated in the future including the world's first hydrogen fuel cell motorbike - the ENV bike which has a top speed of 50mph and a range of 100 miles (HM Treasury, 2007). BMW, GM, Ford and Honda are all currently working on fuel cell powered cars, with Honda recently releasing the Honda FCX Clarity in California, America to select number of customers to trial (Business Week, 2008).

From an urban delivery vehicle perspective, Peugeot and Citroen have developed the Peugeot Partner Origin hybrid van following grant funding from the UK Technology Strategy Board of £1.7 million, towards the £4 million project. Working with Intelligent Energy, the battery powered Partner had a range of 48 miles, but with the addition of a 10kW hydrogen fuel cell system, the range has been extended to 186 miles, with a top speed of 62mph. This has been achieved with a reduction of only 10% in payload volume and an additional weight of 150kg, with the compressed hydrogen being stored in exchangeable racking. The use of hydrogen over electrical power has a major operational benefit - a quicker rate of refueling due to the exchangeable racking that can be changed or refilled, rather than waiting for the battery to be recharged. Like battery electric and natural gas powered vehicles, there is the added advantage of less noise compared to diesel powered vehicles (Fleet News, 2008).

At a larger scale, a demonstration model of the Hytruck C8Hea, hydrogen fuel cell powered 7.5t Mitsubishi Canter was demonstrated in Holland in late 2007, with view to trials being developed. 3 Dutch companies have already agreed to trials including Corus and a major supermarket. If the trials are successful, the technology could be trialled in the UK in the future.

To create the vehicle, the company replaced the existing diesel motor, gearbox, differential and fuel tanks with a completely new-concept driveline, called the Hytruck H2E. It has fuel cells mounted under the cab producing 16kW that draw hydrogen from the 227-litre fuel tank containing 5.8kg of hydrogen at a pressure of 350bar. The energy from the fuel cells is transferred to the batteries, which are mounted where the diesel fuel tanks used to be. The fuel cells provide continuous charge to the batteries (Road Transport, 2007).

Similarly to both the natural gas and electrically powered vehicles, there are a number of companies working to create technology that would allow diesel vehicles to be retro-fitted to become hybrids.

A number of systems are being developed by the partnership between ITM Power and Rousch Technologies, who announced in March 2008 that their systems would accelerate the development of hydrogen fuelled commercial vehicles in the UK. In July 2008, ITM Power unveiled its home hydrogen fuelling station (an electrolyser) that is capable of using either grid power or renewables to cheaply produce compressed hydrogen gas from, which would allow individual households to produce their own hydrogen. Rousch Technologies are working on integrating compressed hydrogen power into normal internal combustion engines and together the partnership will enable the 2 companies to offer the complete package – hydrogen fuelled vehicles and hydrogen refuelling systems.

A demonstration bi-fuel Ford Focus has been outfitted with the technology, which allows the vehicle to travel 25 miles on hydrogen power alone, before running on petrol, which was developed in partnership with the University of Hertfordshire (ITM Power, 2008). Additionally, a bi-fuel Ford delivery van has also being fitted with the technology which allows for an operational range on hydrogen alone of around 135 miles on the highway. A belt-driven supercharger with intercooler was added to the Ford 2.3-litre 4-cylinder petrol engine. Three 5,000 psi hydrogen tanks are stored below the floor of the vehicle (Hydrogencarsnow.com, 2008).

5 VEHICLES AND INFRASTRUCUTURE AVAILABLE

5.1 Introduction

This section identifies a selection of the relevant vehicles that are currently available which are alternatively fuelled and/or meet the Environmentally Enhanced Vehicle (EEV) emissions limits. Information is also provided about the current refuelling infrastructure available in the UK.

It should be noted that the EEV standard does not apply to vehicles that are less than 3.5 tonnes Gross Vehicle Weight, and that in a number of cases, alternatively fuelled vehicles are identified on a manufacturer's website, but may not be available within the UK, or about which further technical information is not available. With specific reference to the EEV criteria with respect to Heavy Duty engines, these engines are applicable to a number of different vehicle shells, and in this respect, the relevant ranges and series have been identified, with as much applicable information as possible.

5.2 Vehicles Available

Table 5.1 provides the information about current market supply of EEV and alternatively fuelled vehicles greater than 7.5 tonnes Gross Vehicle Weight.

Table 5.2 includes information about 3 manufacturers which have a number of EEV compliant engines available but does not provide information about which of these vehicles these conform to.

Table 5.3 provides information about electrically powered delivery vehicles and electric hybrids less than 7.5 tonnes Gross Vehicle Weight.

Table 5.4 provides information about natural gas fuelled delivery vehicles and hybrids less than 7.5 tonnes Gross Vehicle Weight.

Table 5.1: EEV and alternatively fuelled heavy goods vehicles with a gross vehicle weight greater than 7.5 tonnes

Supplier	Ranges Available	Gross Vehicle Weight (tonnes)	Engine Size (L)	Max Power Output	Fuel Type	Other Information	Website
DAF	LF 75	7.5 - 21	4.5	118kW	Diesel	EEV Compliant, Euro 4 and Euro 5 options available	www.daf.com/
	LF 45	7.5	Unknown		Electric/Diesel Hybrid	From the end of 2007 was undergoing field trials with a number of customers. Utilises regenerative braking, with the battery pack containing a hundred 3.4 Volt lithium-ion cells, which when fully charged would cover 2km purely on electric power, sufficient to drive in and out of green zones of city centres.	
	CF75, CF85	Various	9.2 – 12.9	183 - 375kW	Diesel	EEV Compliant, Euro 4 and Euro 5 options available	
	XF105	Various	12.9	300 - 375kW	Diesel	EEV Compliant, Euro 4 and Euro 5 options available	
IVECO	Stralis Range	18 – 26	7.8	200kW	CNG	To be released at the end of the year but not available in the UK at present. EEV compliant.	www.iveco.com
	Eurocargo	12 - 16	Unknown	Unknown	CNG	To be released at the end of the year but not available in the UK at present. EEV compliant, with a range of 450km.	
MAN	TGL	12	Four Cylinder Diesel Engine Lithium Ion (60kW)	162kW	Electric/Diesel Hybrid	Estimated fuel savings of 15%, with a weight penalty of 100kg, compared to a 6 cylinder diesel TGL. Payload capacity of 4.6 cubic metres. The hybrid TGL utilises regenerative braking technology and is EEV Compliant.	www.man-mn.com/
MERCEDES BENZ	Econic ECE R110 - **1823** (4x2 wheeler)	8,16 and 32	6.37	170kW	CNG/LNG or Biogas	Launched October 2007. Meets EEV emissions standard. Can be used for **waste collection, fire and emergency purposes and airport ground services**. Mercedes have produced prototypes of 2 hybrids which were displayed in Hanover, Germany in September 2008, which are a NGT/Electric Hybrid (which has a weight penalty of 500kg), and a Diesel/Electric Hybrid (Econic Blue Tec Hybrid).	www.cngservices.co.uk/documents/mercedes_benz.pdf
	Econic ECE R110 - **2628** (6x2 wheeler)			205kW			
	Atego BlueTec Hybrid	7.5	4 Cylinder Diesel Engine	92kW from Engine	Electric/Diesel Hybrid	Since February 2008, has been under testing with customers including Deutsch Post. Expected fuel savings are in the region of 20%.	www.daimler.com/
			Lithium Ion Battery	35kW from Electric Motor			
		12	4 Cylinder Diesel Engine	160kW		Currently in the demonstration stage. The vehicle is only 60kgs heavier than it diesel counterpart.	
			Lithium Ion Battery	44kW			

	Axor BlueTec Hybrid truck	Unknown	7.2l Engine Lithium Ion	Unknown 44kW from Electric Motor	Electric/Diesel Hybrid	Currently in the demonstration stage, Mercedes claim that there will be fuel Savings in the region of 4 – 10% over the diesel powered Axor, depending on route and driving style.	
Mitsubishi	Fuso Canter (4x2 Wheeler)	7.5	3l Engine Lithium-ion Battery	107kW from Engine 35kW from Electric Motor	Electric/Diesel Hybrid	Payload Capacity of 4.6 tonnes – only 200kg less than a conventional 7.5t Canter. 10 of these have been on trial since August 2008 in the UK with 8 customers – DHL, Amey, Hill Hire, Ringway, Scottish and Southern, Tesco and TNT.	www.mitfuso.com/
Renault	Midlum	12 - 16	Unknown		CNG	Can be operated as a **refuse collection** (payload volumes of 7 – 12 m^3), street flusher, vacuum assisted street sweeper and distribution vehicle for urban deliveries. The CNG gas-tanks are carried behind the cab or in the wheelbase.	www.cngservices.co.uk/documents/renault.pdf
	Puncher (4x2 or 6x2 Wheelers)	20 - 26			CNG, Electric	Can be operated as a **waste collection vehicle** with payload volumes of 13 – 22m^3. CNG gas-tanks carried in the wheelbase. The Puncher can also come in an all-electric version.	
	Premium Distribution (4x2 or 6x2 Wheelers)	18 - 26			CNG	Can be operated in a **refuse collection** application with payload volumes in the region of 12 – 22m^3. CNG gas-tanks carried in the wheelbase	
	Premium Distribution Hybrys	A 320hp DXi 7 Euro 5 Incentive diesel engine, backed up by an MDS electric motor, Optidriver+ gearbox.			Electric/Diesel Hybrid	**Specialist waste collection vehicle**, which is due for trials in Lyon, France in 2009 with waste company Sita. It is hoped that full production will start at the end of 2009.	www.roadtransport.com
Smith Electric Vehicles	Newton	7.5 - 12	N/A		Electric	For more info see table 5.3	www.smithelectricvehicles.com/
Volvo	FE hybrid refuse trucks	Unknown	7l Engine Lithium Ion batteries	320hp 120kW from Electric Motors and Alternator	Electric/Diesel Hybrid	Volvo started trials in the Spring 2008 of the world's first hybrid **diesel/electric refuse collector**, which utilises regenerative braking, and uses the electric motor for starting up and accelerating up to speeds of 12mph. Above this speed the diesel engine is activated. Additionally, the batteries can be used to power the refuse compactor, and can be charged from the mains. It is hoped that there will be savings in the order of 20% in both fuel and carbon emissions. There is also the added benefit of less than, which for refuse collection vehicles in the early morning is of high importance.	www.reuters.com www.greencarguide.com

Table 5.2: Information about 3 manufacturers which have a number of EEV compliant engines available

Supplier	Ranges Available	Engine Information	Fuel Type	Date of Introduction	Website
Volvo	For FM and FH Ranges Only	Volvo's First EEV Engine – an optimised D13 with SCR	Diesel	Due for introduction to the FM and FH Lorry ranges in 2009 offering improved economy, reduced particulates and smoke. Views the use of Selective Catalytic Reduction and Exhaust Gas Recirculation as crucial to meeting future Euro 6.	www.volvo.com
MAN	D08 CR Series (150 to 340hp)	The D08 4.6l and 6.9l engines have been reworked, utilising Exhaust Gas Recirculation Technology	Diesel	Premiered in September 2008 in Hanover, Germany, which can be fitted to the TGL and TGM lightweight and medium weight trucks. .	www.man-mn.com
	D20 and D26 CR Series	The D20 and D26 10.5l and 12.4l D26 CR Series engines have been reworked, utilising Exhaust Gas Recirculation Technology.			
SCANIA	230, 270, 280, 320 and 420 hp Engines	These engines all use Exhaust Gas Re-circulation, except for the 420ho which utilises Selective Catalytic Reduction	Diesel Ethanol (270hp)	Came into use in Sep 2008. The diesel/ethanol engine is claimed to have reduced carbon dioxide emissions by up to 90%.	www.scanianewsroom.com

Table 5.3: Electrically fuelled goods vehicles and hybrids with a gross vehicle weight less than 7.5 tonnes

Supplier	Vehicles Available	Gross Vehicle Weight (t)	Payload Capacity (t)	Payload Volume (m3)	Range (miles)	Top Speed (mph)	Users	Other Comments
Smith Electric Vehicles	*Newton*	7.5, 10 and 12	3.3-7.4	Varies according to specification.	130 - 150	50	Yoyo, TNT, Ceva Logistics, TK Maxx (through DHL), Westminster TranServ, the Balfour Beatty and Mouchel Group (who provide services to Westminster Council)	Available without a body, box body, refrigerated body and aerodynamic body.
	Edison	3.5	0.945 - 2.3	Varies according to specification.	100	50	Translink to Lincoln County Council, Sainsburys, BSkyB, Scottish and Southern, BT, Royal Mail, Crown Records Management	Available as Panel Van, Chassis Cab and Minibus
	Ampere	2.340	0.8	Varies according to specification.	100	70	Unknown	Based upon the Ford Transit Connect Chassis, developed in co-ordination with Ford. Launched April 2008, for release later in the year.
Modec (Box Van)	*Modec*	5.490	2	Varies according to specification	100	50	Tesco, Hilden Water, Amey, Accord (for Transport for London), Islington BC, Centre Parks, UPS, Speedy Hire, Menzies Newspapers	Available as Drop Side, Box Cab and Chassis Cab
Piaggio	*Porter Van*	2.4	0.480	3	45	40	Unknown	Available as Blind Van (with reduced payload of 420kg), Glass Van, Pick Up, Tipper and Big Deck, Range can be extended with Li-ion batteries to 95 miles.
Isuzu	*Micro-Vett 35Q*	3.5	1.65	Unknown	40	40	Unknown	Bespoke Versions and Standard size boxes available. The range can be extended by the use of a Lithium Ion battery, rather than Lead gel battery.
Fiat	*Dublo*	2	0.73	2.3	93	75	Unknown	Aimed at Craftsman, maintenance workers, shop keepers and sale reps, service companies, express deliveries
Fiat	*Fiorino Cargo*	1.7	0.61	2.5 – 2.8	62.5	50	Unknown	Launched in May 2008.
Stevens	*ZeVan*	1.250	0.45	1.8	100	56	Unknown	Launched in May 2008, with sufficient payload volume to CHEPS and Euro Pallets.
NICE	*Mega Multi Truck II Van*	1.12	0.335 - 0.445	3	25 – 60	30	Pret-a-Manger	A range of options, including the tipper and drop side available.

Renault	Maxity electric truck	Unknown at this time	1.5	Unknown at this time	37.5	50	N/A	The vehicle is the aim for a collaborative research project between Renault Trucks and their partner company PVI. Set for a launch by mid-2010.
LDV	*Maxus*	Unknown at this time	Up to 1.446	Unknown at this time	55	85	N/A	Choice of Van or chassis cab. Charging time of 3 – 4 hours. The prototype is currently under going trials with a selection of customers, and is not currently available to buy but expressions of interest are being requested by the company.
Citroen	Berlingo	1.655 – 1.730	0.5	3	60	60	Unknown	Production of this model was stopped in September 2005. This is also known as the Peugeot Partner.

Electric/Petrol-Diesel Hybrids

Supplier	Vehicles Available	Gross Vehicle Weight	Payload Capacity (t)	Payload Volume (m3)	Range (miles)	Top Speed (mph)	Other Information
Iveco	Daily	3.5	1	12	Electric Only – 19	Electric – 30 Diesel - 100	Utilizes regenerative Braking to re-charge batteries (Newteon, 2008)
	Daily	6	3.9	17.2			
Mercedes Benz	Sprinter	3.5	1.5	Unknown	Hybrid - Electric Only - 30km	Unknown	The Hybrid Van has a 70kW Nickel/metal hydride that utilises regenerative braking, but has an additional weight of 350kg.
					Plug in Hybrid – Electric Only – 3 – 4 km	Unknown	The Plug In Hybrid Version has smaller batteries at 30kW, but can be recharged from the mains. Additionally, the weight is only an additional 100kg.
Renault	Electro'road	2	0.385	2.3 - 3	110	60	The Plug In Hybridised Electro'Road, sold alongside the all electric Kangoo, could be recharged in 7 hours, and with addition of a 10 litre fuel tank, had a greatly improved range over the Kangoo. However, after selling only 500 in UK, France and Norway, Renault redesigned the Electro'road in 2007.

Table 5.4: Natural Gas fuelled goods vehicles and hybrids with a gross vehicle weight less than 7.5 tonnes

Supplier	Vehicles Available	Payload Capacity (t)	Payload Volume (m3)	Gross Vehicle Weight (t)	Range (miles)	Top Speed (mph)	Other Comments
Mercedes	Sprinter	1.475	Not Available	3.5	187	Unknown	Meets EEV emissions standard, can run on Biogas, with company claims of 30% fuel savings, 80% noise reduction.
Iveco	Daily	0.915	12	3.5	150	Unknown	Currently in use by City Link in London by with 10 vehicles. The vehicles are EEV Compliant and to further increase range a sixth gas storage cylinder can be added.
	Daily	3.64	17.2	6.5			The vehicles are EEV Compliant and to further increase range a sixth gas storage cylinder can be added.

Gas Powered/Diesel-Petrol Hybrid Vehicles

Supplier	Vehicles Available	Payload Capacity (t)	Payload Volume (m3)	Gross Vehicle Weight (t)	Total Range (miles)	Top Speed	Other Comments
Mercedes	Sprinter (ECE R110)	1.475	Unknown	3.5 - 5.0	675 – 750 (on natural gas only the range is 195 – 289)	Unknown	Is available as a Van, Tipper and Chassis Can, with natural gas tanks stored underneath the floor. Meets EEV standards, can also run on Biogas
Volkswagen	Caddy	0.665	3.2	2.27	350	105	Available from the end of 2008, can also be run on bio-methane.
Citroen	Berlingo	0.6 - 0.8	3	1.655 - 1.730	560	89	Known as the Peugeot Partner, and is also available as an electric vehicle.
Citroen	Jumper	1.45	Unknown	3.5	Unknown	Unknown	Known as the Peugeot Boxer and Fiat Ducato but sold in the UK as the Citroen Relay.
Fiat	Dublo	0.73	3.2	2	389	96	Also available as an electric vehicle.
Vauxhall	Combo	.482	3.05	1620	338 (130 on just natural gas)	103	Known as the Opel Combo in Europe. The dual fuelled vehicle’s emissions, according to General Motors, are 20% less C02, 40% less CO, and 80% less NOX than a similar petrol engine.

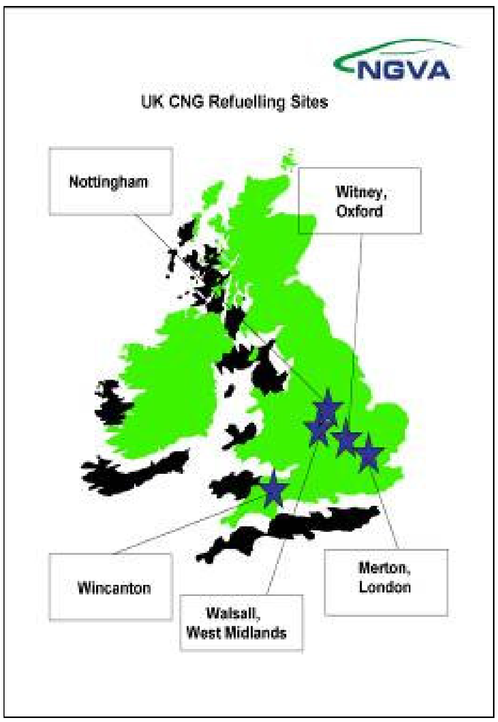
5.3 Alternative Refuelling Infrastructure

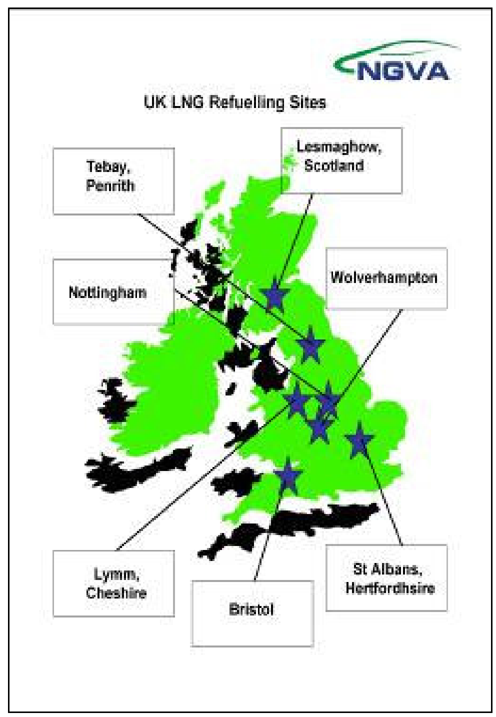
"The availability and costs of alternative fuels is a major factor when purchasing such vehicles. All the alternatively fuelled vehicles will require additional or completely new fuelling infrastructures. Most of the alternatively fuelled vehicles will have either a separate fuel station at a fleet operator's location or can be incorporated into a traditional petrol/diesel fuelling station" (EU PROCURA, 2007).

This was one of the main conclusions of the EU PROCURA report into Market barriers for Large Scale Alternative Fuel Vehicles Procurement, which only considered the fuels of Bio-diesel, Bio-ethanol and Compressed Natural Gas. The National Society for Clean Air report into Biogas also commented that there is "very limited refuelling infrastructure" for natural gas fuelled vehicles.

Figure 5.1 shows the locations of refuelling points for CNG and LNG in the UK which are approved by the Natural Gas Vehicle Association.

Figure 5.1 UK CNG (right) and LNG (left) Refuelling Sites, (NGVA, 2008)





According to these maps, the only natural gas refuelling station in the SLFQP area is in the London Borough of Merton, which is actually on a Borough Council site installed by the Council.

Regarding biogas (also known as bio-methane) re-fuelling stations, the first biogas refuelling station in London was installed in October 2008 in Camden, as part of a collaborative 6 month trial between Veolia Environmental Services, GasRec and the London Borough of Camden. The station supplies a bio-methane powered IVECO DAILY street cleansing vehicle and aims to highlight the suitability of biogas powered vehicle back-to-base operations. It also widens the scope of the trial to allow evaluation of a complete, scalable solution, and provides the opportunity for the

Borough Council to fuel vehicles in its own fleet from the York Way Depot (GasRec, 2008).

As mentioned previously, battery and plug in hybrid electric vehicles need to be left to recharge for a period of time and most operators charge vehicles within depots. However, for owners with just a personal vehicle, there are a small number of electric recharging points available in the SLFQP Boroughs, as shown in table 5.6:

Table 5.6: Availability of Electric Charging Points in SLFQP Boroughs (Newride, 2008)

Borough	Locations	Number of Charging Points
Bromley	The Glades Shopping Centre, Bromley	2
Croydon	None	0
Kingston upon Thames	Seven Kings Car Park, Kingston Town	3
Lewisham	None	0
Merton	None	0
Richmond upon Thames	Old Deer Car Park, Twickenham Road, Richmond	1
	Cedar Road Car Park, Teddington, Richmond	1
Sutton	Gibson Road Car Park, Gibson Road, Sutton	3
	Times Square Car Park, St Nicholas Shopping Centre, Sutton	1
	Brighton Road Car Park, Brighton Road, Sutton	1
Wandsworth	Wandle Recreation Centre, Garrett Lane, Wandsworth	1

In terms of hydrogen refuelling infrastructure, in the past 5 years in the UK, there has only been one refuelling station in Hornchurch, which was operated by BP in support of 3 hydrogen fuel cell buses which were on trial until 2007. However, once this trial had finished, the station was closed. At present, phase 1 of the London Hydrogen Partnership project (2008) is still going ahead with trials of 10 hydrogen powered buses, and as part of this it is envisaged that 2 hydrogen refuelling facilities will be procured by Transport for London (TfL, 2008[29]).

In order to support the installation of additional refuelling infrastructure for alternative fuels, grants were available from the Energy Savings Trust starting in 2005 through the Infrastructure Grant Programme. Through this programme, funding was available for:

- Grants of up to 30 per cent of the eligible cost were available for natural gas/biogas, hydrogen and bio ethanol pumps.
- Grants of up to 40 per cent of the eligible cost were available for electric recharging points.
- An additional 5 per cent was permitted where the station was located in Article 87 (3) (c) region.
- An additional 10 per cent was permitted where the station was located in Article 87 (3) (a) region.
- An additional 10 per cent was permitted where the owner of the refueling/ recharging point was a small to medium sized enterprise (SME)*.
- Receiving funding from other local, regional, national or European community sources for the same eligible costs was not permitted (EST, 2007).

In the 3 years, approximately 23 grants were made by the Energy Savings Trust as shown in table 5.6.

Table 5.6: Energy Savings Trust Infrastructure Grants 2005 – 2008 (EST, 2008)

Fuel Type	No of stations funded	Total Funding (£k)
Biogas	1	362
Electric	82	171
E85 Bioethanol	18	128
E95 Bioethanol	1	33
Natural gas	4	154
Hydrogen	0	0
Total	**106**	**847**

At present although the programme is ongoing, the Energy Saving Trust is no longer in charge of running it, with Cenex now the appointed delivery organisation.

6 PUBLIC SECTOR EXPERIENCES

6.1 Introduction

As part of this study, the relevant Borough Fleet Managers were contacted by telephone and email to request information about the breakdown of SLFQP Borough fleets, and additional material has been found in the SeaRenue Study on the Provision of Biodiesel to the Local Members of SWELTRAC and in local implementation plans. This study wishes to thanks all those consulted as identified in Annex B.

6.2 SLFQP Borough Fleet Experiences

6.2.1 Introduction

In this section an overview of the results from the consultation are presented, with a summary shown in Table 6.1.

6.2.2 Bromley

Bromley's fleet comprises 124 vehicles in total, of which 14 are Heavy Goods Vehicles and 22 are Light Goods Vehicles. At present, 1 Smith Electric Vehicle is in use, with 6 Light Good Vehicles being run on LPG. The 6 LPG fuelled vehicles came about as a result of funding from the Powershift Programme which enabled the Council to purchase 27 LPG dual fuelled vehicles in 1997. It was envisaged that the purchasing and running of vans on LPG would continue within the routine replacement programme. However, the Powershift Programme has now ceased, and additional costs have resulted in a reduction in the number of LPG vehicles.

Additionally, 35 vehicles are run on a 5% blend of Bio-diesel. Previously, the Borough was involved in the SELTRAC Bistro project which was stopped in 2007. The project aimed to produce biodiesel from collected Used Cooking Oil to supply part of the fuel requirements for the Borough's fleet.

Reference is made to alternatively fuelled and low emission vehicles in the Local Implementation Plan (LIP) for the Council which was finalised in 2006, with particular reference towards meeting the Mayor's Ambient Noise Strategy. To this end, the borough aim:

- to promote quieter vehicles and associated activities including by establishing pilot projects to run fleet vehicles on alternative fuels including compress natural gas and hydrogen
- to encourage good vehicle maintenance in council fleet and other vehicles to reduce in service vehicle noise

Furthermore with regards to procurement, the LIP points out that the majority of the Borough fleet is arranged through Contract Hire, which is responsible for maintenance of the vehicles, typically for a period of 6 years. This limits the ability to introduce new technologies, except at the times when the contracts are re-let. Procurement is carried out through approved EC tendering procedures, and future specifications and the criteria for final selection will take account of environmental performance. This will include:

- Fuel type
- Fuel consumption
- Exhaust emissions
- Noise emissions
- Recycled materials
- Scope for recycling at disposal

The LIP states that "at this time, new vehicle specifications will contain the most suitable technology that meets with the needs of the end user and supports the reduction of the impact of vehicle use on the environment. The replacement plan will also indicate the suitability and practicality for specifying any available means of alternative power or new technology for the particular replacement vehicle. Considerations will be given to all possible options including":

- Liquefied Petroleum Gas (LPG)
- Compressed Natural Gas
- Electric Vehicles (EV)
- Hybrid Electric Vehicles
- Bi-Diesel
- Fuel Cell Vehicles
- Exhaust after treatment Devices
- Telematics (London Borough of Bromley, 2006)

However, it is acknowledged by the fleet manager that at present, budgets are restricted and that is a crucial factor. At present, it was felt that hire companies seem to be very cautious about alternatively fuelled vehicles in terms of residual values, and that this was reflected in their rates. Additionally, many manufacturers do not seem to link that well to the EEV standard in terms of the information available to purchasers.

It was suggested that continued support and encouragement through grant programmes such as those previously run by the Energy Saving Trust would assist with further usage of alternatively fuelled vehicles.

6.2.3 Croydon

Croydon's vehicle fleet comprises 180 vehicles, of which a large number are contract hired, (the Council owns 56) using several different hire companies. 142 of these are light goods vehicles with gross vehicle weights less than 3.5t (including Piaggio Porters, Citroen Relays and Berlingos, Ford Transits, and Renault Masters), with 38 vehicles being heavy goods vehicles (including Ford Iveco Cargos, Man TGLs and Mercedes 8414Ds). Diesel is used in 161 of these vehicles, 17 are petrol fuelled and 2 are powered by LPG. The Council uses approximately 385,000 litres of diesel, all of which contains 5% Biodiesel DERV. Previously the council was involved in the SELTRANS Bistro project, along with Bromley, which was stopped in 2007. The project aimed to produce biodiesel from collected Used Cooking Oil and it was envisaged that the project could have supplied 20% blend of biodiesel for the council's fleet.

There is no current usage of natural gas vehicles at present, but several years ago there were a few CNG vehicles in use by the Council. However, there were reliability problems and as a result these were taken out of service. There is still the old 'slow fill' CNG refueller in the Council's depot but it hasn't been used for many years.

Similarly there aren't electric vehicles in use at present, but previously 4 electric Peugeot Partner Vans were used by building maintenance and the Meals on Wheels service for a period of 7 years. It was commented that in general they were quite successful and reliable. However, when problems did occur with them, they had to be repaired by specialist Peugeot workshops that had one or two trained staff. As such, this meant that a vehicle could have been out of service for 1 or 2 weeks for a relatively minor defect. At the end of their useful life, the vehicles were disposed of, usually when the batteries failed because this would have required a £3-4,000 replacement. Electric replacements were considered to replace them but at the time, 'full-size' electric vans were rare, with most of the available vehicles being of the 'micro type' that were considered to be of limited use.

The main barrier perceived by the Fleet Manager to Enhanced Environmentally Vehicles was cost, especially as services need to be operated to a tight budget. It was also felt that some of the more "experimental" vehicles that are not as technically mature are perceived as being unreliable. Additionally, it was commented that a lack of refuelling infrastructure is a further barrier to the increasing use of alternative fuels. It was suggested that in the future, driving forces behind further usage could be allowances made on duty, or a specific requirement be made to use Environmentally Enhanced Vehicles such as through Low Emission Zone type legislation.

It should be noted that in Croydon Council's Travel Plan, there are 2 measures affecting fleet vehicles, notably:

- To introduce biodiesel from sustainable sources for all fleet vehicles at a minimum 5% mix with standard diesel for all fleet vehicles
- To continue vehicle replacements with more efficient vehicles

6.2.4 Kingston

Kingston's vehicle fleet is 97 vehicles strong, with a large number of these on contract hire through Fraikin, and a number on lease agreements. The contract hire deal with Fraikin is for 7 years but some of the older vehicles are on a fixed annual fee or cost plus basis and will be replaced on a contract hire basis over time. Procurement is devolved in Kingston Council so some departments choose not to benefit from the corporate contract.

There are no heavy goods vehicles operated by Kingston Council amongst their fleet as all direct services are outsourced. Of the 97 vehicles, 43 are light goods vehicles (including Ford Transits, Citroen Berlingos, Renault Masters and Kangoos), with the remainder of the fleet comprising a number of minibuses, people carriers and cars, used by Community Services and other departments. 74 of these vehicles are diesel fuelled, 2 are petrol fuelled and 21 powered by LPG. Of those that are powered by LPG, all are dual fuelled. Kingston Council has looked into using biofuels previously but the reasons of cost; the installation of a facility and bunkering outweighed any financial benefit even in the long term given the small size of the fleet.

Kingston Council have previously trialled an electric Citroën van in the past but due to reliability problems – "*that it spent more time off the road than on it*" - it was not a success and the Council have not looked into this option any further. They also operated a dual fuel CNG tipper for a period of time but this was not deemed a success either.

With regards expanding use of alternative fuels, Kingston Council have previously investigated and discounted use of bio-fuels. LPG is no longer supported by manufacturers, and retro fitting of vehicles led to problems with warranties with vehicle manufacturers. Thirdly from past experience, "*users are loathe to use the dual fuel facility presumably due to a lack of outlets*." It was also commented that hybrid manufacturers do not meet the Council's requirements for vans, and that as advanced Euro emission regulations become more effective, there will be increasingly marginal benefits.

Reference to the Borough's procurement policy is made in the Local Implementation Plan (2006), and states that as tenders are invited for contracted out services like rubbish collection, the specification requires quotes using alternative fuelled vehicles. Particulate traps should be utilised on vehicles exceeding 7.5 tonnes. The objective to be achieved through the terms of contracts is that the vehicles must meet Euro II standards plus a reduced pollution certificate if they are to be employed by RBK after Dec 2007 and Euro IV (with anything not meeting that standard needing a particulate trap and NOx abatement equipment) if they are to be employed by RBK after the start of 2010.

Firm commitments from the top and political impetus from its members were deemed to be necessary to further the use of EEV and alternatively fuelled vehicles.

6.2.5 Lewisham

Lewisham's vehicle fleet is comprised of 362 vehicles in total, 262 of which they own outright, and 100 of which are on contact hire, including 10 Toyota Priuses. Of the 262 vehicles which the council own, 162 are less than 3.5 tonnes in weight, with 50 large buses and 50 Heavy Goods Vehicles.

The fleet is fuelled by a mixture of petrol, diesel (5% biodiesel blend) and LPG, the latter of which is used by 36 vehicles, and stored at the Council's fleet depot. During 2007, 1,070,096l of B5 Biodiesel, 60,000l of petrol and 33,559 litres of LPG were used by the Borough fleet vehicles. This quantity of biodiesel is the highest among the SLFQP Boroughs, and the Borough council were previously involved in the

SELTRAC Bistro project, along with Bromley and Croydon, which was stopped in 2007. At present, other than the Toyota Priuses there is no usage of electric or natural gas powered vehicles.

From the point of view of barriers to increasing further usage of alternative fuels, the fleet manager felt that there was a lack of incentive from central government towards furthering their usage, and that there was a lack of infrastructure for natural gas fuelled vehicles. He did feel that electric vehicles will have a future, particularly within urban areas, but they must be suitable for the purpose intended .i.e. back to base operations and overnight stand downs.

From the Environmentally Enhanced Vehicle perspective, the Fleet Manager explained that he was not familiar with the term EEV, and elaborated that in most cases, manufacturers only state whether the vehicle is Euro 4 or Euro 5. He also commented that manufacturers are developing cleaner engines fuelled by conventional fuels, rather than looking to use alternative fuels.

Reference is made to alternative fuels and low emission vehicles in the Council's Local Implementation Plan which was finalised in 2006. This points out that the Council's energy policy commits it to:

- Use vehicles with low fuel consumption and pollution reducing technology and ensure their regular servicing and energy conscious operation
- Promote and facilitate the use of alternative modes of transport

Secondly, the Council's environmental policy commits it to:

- Reduce emissions of greenhouse gases from its use of energy and fuel
- Improve local air quality
- Reduce noise levels

With regards to vehicle procurement and replacement policy, the Council's Fleet operations have been the subject of an Eco Management and Audit Scheme (EMAS) review and over time the Council has sought to replace its vehicles with those using cleaner technology whilst adhering to the BATNEEC (Best Available Technique Not Entailing Excessive Cost) principle. The Council's Staff Travel Plan Steering Group is investigating the possibility of:

- The LPG fuelling facility at the Council's fleet depot, being made available for staff to use for their own vehicles. The intention would be to further encourage the use of alternative fuels and increase volume through the station.
- The restriction of car loans provided to staff members to purchases of dual fuel vehicles (LPG / Petrol) or other 'greener' fuelled vehicle types.

The Council has considered the current 'greener' fuel and vehicle options, and when replacing vehicles, presently follows the guide in table 6.1. "1" in each case indicates the preferred option with "2" as the alternative only if "1" can not meet the end user department's operational needs.

Table 6.1: London Borough of Lewisham replacement policy

Option 1	Option 2
Cars and light vans	
Electric where it meets operational needs	LPG / petrol where the above is unsuitable
Small buses and Medium vans	
LPG / petrol	ULS Diesel and CRT where the above is unsuitable
Midi buses, large Vans, Refuse vehicles and Large buses	
ULS Diesel and CRT	

6.2.6 Merton

In 2007, Merton's vehicle fleet was made up of 218 vehicles of which 72 were owned by the council, and 146 were hired from Dawson's Rentals and Gulliver's. Unlike with other borough fleets, Merton used only natural gas and low Sulphur Diesel to fuel their fleet (SeaRenue, 2007). As mentioned in the Local Implementation Plan (2006), compressed natural gas was introduced to a range of operating vehicles including car derived vans, minibuses and trucks. However, a number of problems were experienced including:

- A lack of technical / spares backup
- Poor starting and running
- Premature engine failure
- Engines cutting out

Where a lack of back up was experienced, there were a number of instances where vehicles remained unused for several months at a time. At the time that the LIP was written, most of the natural gas fuelled vehicles were reaching the end of their operational life. The natural gas fuelled car derived vans had to be maintained until 2007, when the supply contract with British Gas expired, but at the time, there were still 17 CNG powered buses and 1 refuse vehicle in operation. Those vehicles which had been natural gas fuelled were subsequently converted to run on diesel, like the majority of the fleet and used 936,000 litres of low Sulphur Diesel in 2007.

The LIP also makes reference to emissions standards for subcontractors, specifying F.M. Conway Ltd, who the Council uses for highway maintenance. These vehicles comply with the Euro III standard, and all new vehicles purchased comply with either Euro IV or, where available, Euro V standard. In addition, F.M. Conway Ltd have investigated the feasibility of alternative fuels, such as biodiesel from used cooking oil, for some of their fleet.

The Borough currently has the only natural gas refuelling infrastructure point in the SLFQP area (figure 5.1), with fuel bunkers installed at this location, and previously supplied by British Gas. However, the fuel supply is not currently under contract, partly due to concerns over potential fuels shortages and fuel consumption. Further expansion is not possible at this site because of a lack of space for an additional tank (SeaRenue, 2007).

6.2.7 Richmond

Richmond's vehicle fleet is made up of 300 vehicles, of which 210 are owned by the Council, and 90 are leased. Unlike other councils, there is no usage of alternative fuels whatsoever, with the entire fleet using diesel except, for the Mayor's car, which is a Toyota Prius.

In 2007 they completed a trial of using 100% biodiesel, which had been produced from used cooking oils, in a selection of vehicles including new and fifteen year old vehicles, light car derived vans, heavy goods vehicles and large passenger vehicles. These were specifically chosen to provide a cross sample in terms of age and technical development. The trial was a complete success with the results showing that 100% Biodiesel could be used as a straight forward replacement fuel for diesel. Research has also identified a range of chemicals that can overcome the issue in the winter of wax in the fuel freezing at the "Cold Filter Plugging Point". In May 2008, the decision was taken to issue a tender for supplies of Biodiesel sourced from Used Cooking Oil for 3 years, with an option to extend for a further year, which would specify that the Cold Filter Plugging Point be reduced to minus 7.5 degrees Celsius.

At time of going to tender the Council fleet used 620,000 litres of diesel per a year, and the tender was put out for up to 750,000 litres of UCO sourced Biodiesel. Even in the event that there is a particularly cold winter which would lead to temperatures below minus 7.5 degrees Celsius, the Council would maintain active contracts for conventional diesel. Consultation undertaken by the Council with manufacturers of various vehicles has revealed that some will accept warranties with 100% Biodiesel with other up to 50% (London Borough of Richmond, 2008).

6.2.8 Sutton

Sutton's vehicle fleet is made up of 163 vehicles, a large number of which are supplied by London Hire, who supply the majority of the vans and light vans, as a result of a contract which started on April 2006. Of these, 34 are heavy goods vehicles (which are mainly used for refuse), 8 are medium vans, 78 are small vans, 26 are 7 – 12 seat minibuses, 11 are maintenance and cleaning vehicles including street sweepers, and 6 are other which include forklift trucks.

The majority of the fleet (155 vehicles) is fuelled entirely by diesel with 7 vehicles fuelled by petrol and 1 forklift truck electrically powered. Total fuel usage in 2007 accounted for 620,000l (570,000 diesel, 50,000l petrol), with all of the diesel being 5% Biodiesel blend, which is supplied through a contract with Petro Plus.

6 of the vehicles have dual fuel options for LPG, but this option is not used. At present, all of the diesel powered vehicles are supplied with 5% biodiesel. However, in July of 2008, a trial commenced between the Borough and London Hire to trial a 30% biodiesel blend across a range of 40 operational vehicles. It is envisaged that

the trial will run for a number of years to investigate whether there are any potential negative impacts on the engines or operational status.

As the Borough fleet manager explained, the Borough has operated a number of alternatively fuelled vehicles as part of their fleet previously. These included 5 – 6 Citroen Berlingo electric vans as part of a leasing contract, which finished late spring 2004. These were used by the meals on wheels service, which were driven by volunteers, and were popular with the drivers. The vehicles were re-charged over night with no problems experienced, and there were additional benefits from the vehicles being quiet, clean and reliable. However, there were issues associated with the leasing arrangements for the batteries, which cost £5000 for replacements, which is why further usage has not been carried out, and the vehicles have been replaced with diesel equivalents. Similarly, the Borough has tried using natural gas to power a number of heavy goods vehicles, but these suffered from a lack of power. A contract had also been agreed with a supplier but as the quantity of fuel used decreased, costs associated with the vehicles increased to such an extent that it was no longer worthwhile continuing with their usage. When either the natural gas or electric vans were off the road for repairs, it was necessary for the Council to hire in diesel powered vehicles, because gas powered vehicles were not available on a daily basis (Sutton, 2004).

Currently, 11 of the heavy goods vehicles are Euro 5 emissions compliant, with another 5 soon to be modified to Euro 4. The majority of the rest of the fleet are Euro 4 and under 3 years old. When the Borough undergoes a vehicle replacement programme of replacing older vehicles in the fleet, they ensure that the latest technology engines are fitted to their vehicles, including within the contract with London Hire, where Euro 4 vehicles are sought. When replacing fleet vehicles, there aren't any constraints as to regards trialling of other types of technology and fuels, should the need arise, and the council are in the process of undertaking further research to identify alternative fuels for the future, in the wake of the issues previously experienced (Sutton, 2006).

In communications with the fleet manager, it was felt that there is limited infrastructure for re-fuelling natural gas fuelled vehicles at present, with the closest location being at the London Borough of Merton's depot. When the fleet previously used natural gas fuelled vehicles, there was a refuelling station in Therapia Lane. However, this was refurbished late in 2007, with 2 biodiesel tanks being installed – for 45,000l capacity for B5 and 20,000l for B30 (SeaRenue, 2007). Similarly there aren't any storage facilities for LPG on site. It was also felt that there is an additional cost associated with Biodiesel, and that initially, there were problems finding a supplier for the trial, which has now been resolved.

Sutton is a Borough that is constantly looking to improve their emissions and reduce their impact on the environment as demonstrated through their environmental sustainability and management system (EMAS) and this is a driver for reducing emissions from fleet vehicles.

6.2.9 Wandsworth

Wandsworth's vehicle fleet is the largest in the SLFQP area at 343 vehicles with the Council also responsible for 157 items of plant and equipment. Of these, the majority of vehicles are diesel fuelled, with a number of vehicles alternatively fuelled. In the Local Implementation Plan for Wandsworth Council, in Dec 2005, 15% of the fleet were operating on cleaner fuels, but by 2007 this had decreased to 40 light cars and vans, the majority of which use LPG. The alternatively fuelled vehicles were part funded by the Transport Energy Powershift Programme. Previously in the 1970s they had an electric van, but now there are 5 electric golf buggies in use in Battersea Park by the park's police, whilst the remaining vehicles also use Ultra Low Sulphur Diesel.

The decision to use ULSD was made after the Government introduced a new rate of duty for sulphur-free petrol and diesel, set at 0.5 pence per litre lower than the rate for ultra-low sulphur fuels on the 1st Sep 2004. Previously, the Council has also investigated the use of cleaner fuel options including the use of water diesel emulsion. However, following cost/benefit analysis, this was not considered viable. The Council subsequently investigated the use of a non-metallic diesel fuel additive called 'Chemecol', and the potential for use of bio-diesel and compressed natural gas. The 'Chemecol' would have been added to the diesel tanks on site, with trials in other London boroughs demonstrating reduced emissions of particulate and gaseous emissions. Status of these investigations is not known at the time of writing (Wandsworth, 2006).

During 2007, the fleet used approximately 220, 000l of diesel, all of which contained a 5% blend of bio-diesel and is stored on site at the Council's depot. This figure does not include any usage by refuse vehicles, which are operated by Biffa. At present, there is only one fuel tank at the depot, with electric recharging points installed in Battersea Park for use by the park police, although there are a number of alternative fuel recharging points available to the public, and advertised by the Borough's website including:

- As of October 2004, the following outlets supply LPG for car and van use:
  - BP - Wandsworth connect, Swandon Way, Wandsworth SW18 1EW, 020 8523 4087, 24 hrs / 7 days
  - BP - Trinity Service Station, 62-64 Trinity Road, Tooting Bec, London SW17 7DW, 020 8682 7090, 6am-11pm / 7 days
  - Shell Savoy, 262 York Road, Wandsworth, London SW18 1TP, 020 7801 9970, 24hrs / 7 days
  - Sainsbury's Supermarkets, Nine Elms (485), Wandsworth Road SW8 2LF, 020 7622 9426, 24 hrs / 7 days
- A CNG dispenser is located within the borough at a BP filling station adjacent to New Covent Garden market.

With regards to vehicle replacement and procurement policies, the Borough is currently in the process of replacing all of their vehicles, and would like their new vehicles to be at least Euro 5 compliant. Contractors also have to comply to standards with all with all waste and recycling subcontractor vehicles needing to comply with the Euro 3 standard.

6.3 Summary

Table 6.2 shows a summary of the SLFQP Borough fleet structures, with the barriers and incentives/drivers to furthering use of low emission/alternatively fuelled vehicles.

A number of borough fleet managers have explained that budgets are restricted at the moment, and a number of Boroughs benefited previously from the PowerShift grants, converting a number of vehicles to LPG. It is felt that there is a lack of infrastructure available for refuelling, particularly for natural gas fuelled vehicles, whilst it is interesting to note that a number of Boroughs have previously used natural gas and electric vehicles, but experienced multiple problems and have not subsequently continued to use them. Furthermore, a number of fleet managers explained that vehicle manufacturers do not link all that well into the Environmentally Enhanced Vehicle standard, possibly as a result that it does not apply for vehicles under 3.5 tonnes gross vehicle weight, which are the majority of Borough fleet vehicles.

There were a number of incentives/drivers given as regards expanding use of EEVs and alternatively fuelled vehicles including financial - continued support and grants from organisations such as the Energy Saving Trust and allowances on duty and political impetus from politician , a firm commitment from senior management and environmental and sustainability responsibilities. One borough fleet manager also felt that specific requirements within legislation to use such vehicles (such as Low Emission Zones) would also be a driving force behind increasing EEV usage.

It is interesting to note that two Councils are in the process of/have just completed trials of high percentage blends of bio-diesel, one of which is looking to roll this out across their entire fleet.

Table 6.2 Summary of SLFQP Borough Fleets

Borough	Total Fleet Size	Current Fleet					Previous Used		Barriers Commented Upon	Incentives/Drivers
		Electric	LPG	CNG	Number of Vehicles using Biodiesel	Biodiesel % Blend	CNG	Electric		
Bromley	124	1	6	-	35	5	-	-	Cost as budgets are tight. Hire companies cautious about residual values of alternatively fuelled vehicles. Many manufacturers do not link well to the EEV standard.	Continued support and encouragement through grants from organisation such as the Energy Savings Trust.
Croydon	180	-	2	-	161	5	Yes	Yes	Cost as budgets are tight Lack of refuelling infrastructure Perceived Reliability concerns	Allowances on duty LEZ type legislation
Kingston	97	-	21	-	0	n/a	Yes	Yes	Reliability concerns from previous usage Cost of infrastructure for bio-fuel for the small fleet Dual fuel options not well used by users due to a lack of refuelling outlets LPG is no longer supported by manufacturers and retrofitting affects warranties	A firm commitment from the top Political impetus from Members
Lewisham	362		36		Unknown	5	-	-	Lack of CNG refuelling infrastructure Lack of central government incentives Many manufacturers do not link well to the EEV standard.	Electric vehicles will be applicable for urban area return to base operations
Merton	218	-	-	18	0	n/a	Yes	-	Reliability and cost of natural gas vehicles Lack of room to expand fuel storage at depot	

<table>
<tr><th rowspan="2">Borough</th><th rowspan="2">Total Fleet Size</th><th colspan="5">Current Fleet</th><th colspan="2">Previous Used</th><th rowspan="2">Barriers Commented Upon</th><th rowspan="2">Incentives/Drivers</th></tr>
<tr><th>Electric</th><th>LPG</th><th>CNG</th><th>Number of Vehicles using Biodiesel</th><th>Biodiesel % Blend</th><th>CNG</th><th>Electric</th></tr>
<tr><td>Richmond</td><td>300</td><td>-</td><td>-</td><td>-</td><td>6</td><td>100</td><td>-</td><td>-</td><td colspan="2">Just finished trial for 100% bio-diesel from UCO to roll out across whole fleet.</td></tr>
<tr><td rowspan="4">Sutton</td><td rowspan="4">163</td><td rowspan="4">1</td><td rowspan="4">6 Dual Fuel</td><td rowspan="4"></td><td rowspan="4">155</td><td rowspan="4">5</td><td rowspan="4">Yes</td><td rowspan="4">Yes</td><td>Poor previous experience of natural gas vehicles</td><td rowspan="2">EMAS and Environmental Sustainability Responsibilities</td></tr>
<tr><td>Lack of CNG refuelling infrastructure</td></tr>
<tr><td>Cost of replacing electric batteries</td><td rowspan="2">Just started a trial with 40 vehicles on 30% bio-diesel</td></tr>
<tr><td>Additional cost of bio-diesel</td></tr>
<tr><td>Wandsworth</td><td>343</td><td>5</td><td>40</td><td>-</td><td colspan="2">Majority of fleet use 5%, except for those on ULSD</td><td>-</td><td>Yes</td><td>Cost benefits of Water-Diesel Emulsion</td><td></td></tr>
</table>

7 PRIVATE SECTOR EXPERIENCES

7.1 Introduction

In addition to Borough Fleet Managers there are a number of private hauliers and operators who are currently using a number of low emission and/or alternatively fuelled vehicles within their current delivery fleets that have been consulted with as part of this study. The authors of this study would also like to thank all those consulted as identified in Annex B.

7.2 DHL

DHL, Deutsch Post and Postbank form Deutsch Post World Net Group, one of the leading companies for management and transportation of goods, information and payments, employing over 500,000 employees in more than 220 countries and territories. As part of the company's sustainability program, there are the two aims of minimising emissions of carbon dioxide and improving local air quality.

Within the UK, the company are currently trialling 2 electric hybrid trucks – the Mercedes-Benz Atego BlueTec Hybrid and the Mitusbuishi Fuso Canter Eco Hybrid, both as part of DHL Express' operations. The Atego BlueTec Hybrid's battery pack is used initially when the engine starts up, and assists the diesel engine at low and medium speeds, with the vehicle running on the diesel engine alone when at cruising speed (Deutsch Post World Net, 2008).

The Fuso is being tested as part of trials of the vehicle by 10 other companies in and around London, with anticipated reductions in fuel of 15%, compared to diesel models. The Fuso has been in use in Japan since 2006, with over 300 currently on the road, and has achieved fuel savings of 20% through the use of an automated engine stop-start system, which has not been fitted to the UK model. The trial of the Fuso is due to finish in September 2009, with a key question to be answered is whether the £6,000 purchase price premium can be recouped through the lower fuel costs (Meczes, R, 2008).

In addition, DHL are currently trialing 4 electric delivery vehicles in a number of locations around the UK through their Dept Stores and Fashion section. All of these vehicles were manufactured by Smith Electric Vehicles:

- A 9t ambient box vehicle is being trialed as part of the Retail Freight Consolidation Centre in Bristol, targeting the Broadmead Shopping Centre and Cabot Circus.
- A 9t chilled vehicle at the Hatton Cross Consolidation Centre serving BAA Heathrow.
- A 9t ambient box vehicle offered to a number of customers on 2 – 3 month trials (currently Selfridges, Burberry and Carphone Warehouse
- A 10t ambient box vehicle operating out of Colnbrook near Heathrow, on behalf of TK Maxx (DHL, 2008).

In addition to trials of electric and electric hybrids, DHL have also been conducting trials of 100% blend bio-diesel in 2 heavy Euro 3 trunking vehicles – a Mercedes-Benz 6x2 Actros and 6x2 Axor. It was recorded in the FTA's September 2008 that, "*fuel consumption in these 2 vehicles had increased 4%, equating to an additional 2000 litres/year, with an additional 8% in repair and maintenance costs. This has been the result of two additional oil and filter changes needed each year. On the other hand though, there has been a 60% reduction in carbon dioxide emissions, and despite occasional problems with fuel waxing in the cold weather, DHL will keep exploring it*."

7.3 TNT

TNT is a leading international courier and freight transporter, operating worldwide, with 16,700 pick-up and delivery cars, vans and trucks and than employing more than 160,000 people. In the UK, TNT operates through their EXPRESS and POST divisions. As part of the company's environmental and sustainability policy (TNT Planet me), they derive 15% of all its electricity requirements from renewable sources, and pledge to develop greener vehicles and fuels.

The London-based TNT Express Team are currently also taking part in the Mitsubishi Fuso Canter Eco Hybrid trials that DHL are participating in, with the vehicle operating out the of the Slough depot.

At a company-wide level, following completion of an 18 month trial (from Dec 06 – May 08) of a Smith Electric Vehicles Newton 7.5t all electric delivery vehicle, which was based in the company's Barking Depot, London, TNT announced in June 2008 that there would be a large scale expansion of the use of this vehicle. The trial produced a number of benefits, with the vehicle savings £1,750 per year from being exempt from the London Congestion Charge. It was originally hoped that the vehicle could be recharged for £25 per week, compared to diesel costs of £105, but actual costs were £40 a week, with diesel prices now costing £200 for equivalent diesel units. These savings do need to be offset against the additional cost of the vehicle, approximately twice the price of equivalent diesel models (FTA, 2008[61], TNT, 2006). Prior to the trial, the company hoped to roll out 200 of the vehicles in a number of locations. However, this has subsequently been revised and they are now rolling out 100 by the end of 2009, at a cost to the company of £7 million, with carbon dioxide savings of 1.3 million kilograms. At present, 40 have been supplied so far (TNT, 2008).

7.4 Wincanton and Sainsbury's

Wincanton are a European leader in delivering supply chain solutions with over 30,000 employees and operating a vehicle fleet numbering 6000, with 80% of employees are based in the UK and Ireland. Wincanton have clients in all sectors including Sainsbury's, Tesco, Waitrose, B&Q, Argos, Honda, Volvo, BASF and Shell (Wincanton, 2007).

Through consultation with Sainsbury's and Wincanton, information has been made available about Sainsbury's supply chain, which is operated by Wincanton, but whose vehicles are owned by Sainsbury's. At present, the majority (75%) of vehicles operated are compliant to Euro 3 emissions limits, with 14% Euro 4 and 11% Euro 5. However, Sainsburys are implementing their vehicle replacement policy which is seeing older vehicles being replaced with the aim for 42% of the fleet to be Euro 5 compliant by the end of 2008, with the entire fleet Euro 5 compliant by the end of 2012. This will lead to the emissions savings shown in table 7.1.

Table 7.1: Emissions savings from Sainsbury's vehicle replacement policy by 2012

Pollutant	Savings (kgs per annum)
Nitrous Oxides (NOx)	63.7%
Carbon Monoxide (CO)	35.3%
Hydrocarbons (HC)	36.8%
Particulates (PM)	82.5%

Currently, Sainsbury's are trialling a number of vehicles including a dual fuel natural gas vehicle, and a trial with a dual fuel hydrogen vehicle is due to start shortly. To date, however, they have not found a solution that is practical and cost effective (nor environmentally desirable) but the options are under continuous review. Bio-diesel is in use at present with a 5% bio-fuel mix, which has been driven by legal requirements rather than a business desire as the company are having to change more fuel filters and are experiencing bacteria within fuel systems.

Furthermore, in August 2008, Sainsbury's announced that it would be the first supermarket to make it's daily food deliveries (500km round trip) from their Bristol Depot to their new flagship environmental store in Dartmouth by a bio-methane (derived from landfill) fuelled delivery vehicle. The Mercedes Benz Axor has been modified with the addition of Clean Air Power's Genesis System, which is described in section 4.4. (Sainsbury's, 2008[49]) It was announced in February 2009 that the use of the system has allowed half of the diesel required to be substituted with methane derived from landfill, and this had led to emissions reductions of 30%. IN addition, Sainsbury's placed an order for five more lorries to be fitted with the Genesis system (CILT, 2009).

There are a large number of barriers which Sainsbury's have commented on regarding further uptake of alternative fuels and alternatively fuelled vehicles. As was raised in the recent Gallagher Review, there are questions over the sustainability of some fuel supplies that have other environmental impacts. There is an additional cost associated with such vehicles that has to be funded and the benefits need to lead to a return on the capital employed. Furthermore, there are issues associated with reliability of equipment, associated infrastructure and back up support in event of problems and obtaining operating leases.

From the point of view of large operator, is important that such vehicles and fuel usage is scalable and that they can implemented across the whole network – "we need a solution that can allow us to use all vehicles at all parts of the UK" (Sainsbury's, 2008[47]).

7.5 Sainsbury's Home Delivery Fleet

As commented above, for the supply chain and distribution, Sainsbury's need a solution that can be used across all parts of the UK. However, the online delivery fleet which is made up of approximately 1000 vehicles is operated out of the stores themselves and the vehicles do not tend to travel to different parts of the UK. Since 2007, the fleet has been trialling the Smith Electric Vehicles Edison van, which has a gross vehicle weight of 3.5 tonnes. Through discussions with the Home Delivery Manager, Simon Skeet, it has been revealed that Sainsbury's aim to have 20% of the home delivery fleet converted to electric power by April 2009, which will save an estimated 45 tonnes of carbon dioxide, with each van completing approximately 100 deliveries per a week. The majority of these will be based in London. After a period of fine tuning, the vehicles have achieved a high level of driver acceptance and Sainsburys have also benefited from less noise associated with their operation.

7.6 Tesco Home Delivery Fleet

Similarly to Sainsbury's, Tesco also took the decision purchase a number of electric delivery vehicles to operate amongst their home delivery fleet of 2000 vans from around 300 stores (Martin, A, 2008). At present, Tesco have 15 MODEC electric delivery vehicles operating around the UK at locations including Belfast, Birmingham and Glasgow. 2 of these are operating from stores in London – Bromley by Bow and New Malden. At the time of purchase, no trial had been undertaken of the vehicles, and the decision was for a one-off purchase of the vehicles. At the time, MODEC was chosen over Smith Electric Vehicles due to necessary payloads. So far there have been no problems associated with operating the electric vehicles, with the 2 operating out of the Bromley by Bow store "becoming reliable". Initially however, due to the early stage of development at the time, there were some problems with software. In the future, the company are looking into buying further quantities of electric vehicles, but this will not be during the current year.

In addition to using electric vehicles, Tesco are currently working with Connaught engineering systems retro-fitting some of their vehicles to become diesel-electric hybrids (as described in section 4.6). At present, trials are occurring with 6 of these vehicles to investigate how much fuel can be saved. It is hoped for savings in the range of 15 -20% but at present it is too early to comment, as is the case regarding any operating problems. Tesco are also undertaking trials of the Mitsubishi Fuso Canter Eco Hybrid similar to DHL and TNT. However, in the words of the fleet engineering manager, Duncan Vavangas, "Tesco are willing to trial anything".

Duncan also commented that potentially in the future, he could see potential for compressed natural gas vehicles, supplied by biogas created by food waste digesters. However, at present no CNG vehicles are used by Tesco, and there is firstly a need to source such vehicles and check that there are no operational problems, before working out how to produce the biogas (Tesco, 2008).

7.7 John Lewis Partnership

The John Lewis Partnership is the partnership of 69,000 partners (all of whom are staff), who own the retail businesses of the John Lewis Department stores and online and catalogue business, Waitrose supermarkets and Greenbee (a production unit and farm). These comprise 221 retail outlets plus associated home deliveries which for Waitrose are operated by Ocado (John Lewis Partnership, 2007).

In order to meet these responsibilities, the John Lewis Partnership has a vehicle fleet of over 2,000 vehicles and trailers, which travel approximately 34 million miles per year, and an increase in the use of flexible home deliveries and internet shopping is increasing the mileage travelled by the partnership's commercial vehicles. Of the fleet, 1300 vehicles are a blend of Euro 3, 4 and 5 emissions limits, and many of the pre-Euro 3 vehicles have been fitted with regenerating to reduce carbon monoxide and hydrocarbon emissions. The Partnership, through it's six year vehicle replacement cycle, is replacing vehicles to comply with the London Low Emission Zone, which stipulates that Euro 4 engines will be required by 2012, as well as currently equipping vehicles with the latest Euro 5 engines where available. The deputy head of transport was unaware of the term Enhanced Environmentally Friendly Vehicle (EEV).

The Partnership is currently trialling a 7.5 tonne electric/diesel hybrid in London and is currently using 5% Biodiesel in preparation for this stipulation in the RTFO. In addition to this, the partnership are currently trialling 94% plant oil (produced from Pure Plant Oil (PPO)) in 5 DAF CF 75 tractor units. As of September 2008, the vehicles had covered 300,000km without any modifications to the engines and there had been no difference in fuel consumption, no loss in performance or effect on engine life according to the fleet engineer, Ray Collington, in the FTA newsletter (Sep 2008).

Other than this, the Partnership have explored many avenues including the use of CNG, LNG and LPG, and it was felt by the David Sheppard, Deputy Head of Transport, that "unless there is a major breakthrough with engine technology to allow engines to operated on these fuels in a reliable manner together with longevity there is little merit in trialling the fuels at present". Furthermore, it is uncertain how far the Partnership will pursue the use of PPO because of "a lack of any solid Government leadership and the fluctuating prices in the commercial market" (John Lewis Partnership, 2008).

7.8 PF Whitehead

PF Whitehead are a Croydon based European transport logistics operator providing transportation logistics, home deliveries and storage solutions to a number of clients including IKEA, DHL and Wells and Young's Brewing Company. Their vehicle fleet consists of more than 50 vehicles ranging from 1 tonne vans to 44 tonne articulated lorries all of which are applicable to a number of operational sectors. PF Whitehead are committed to their green agenda and to reducing lorry journeys wherever possible, and have been involved in recent work with the SLFQP with regard to freight consolidation centres (PF Whitehead, 2007).

In addition to this, PF Whitehead were one of the first companies to place an order for the all electric MODEC zero emission delivery vehicle early in 2007. It was envisaged that the vehicle would be used to transport smaller deliveries into town centres, once loads from large lorries had been consolidated. However, due to various problems, this was not pursued further (PF Whitehead, 2008).

7.9 Transco

Transco National Logistics delivers and stores engineering and other material for National Grid – Transco's gas supply business, and operated 35 articulated vehicles from the National Distribution Centre in Birmingham in 2001. The company has a strong environmental ethos with their Environmental Management System being ISO 14001 accredited in 1999, and as part of their environmental responsibilities they set themselves three projects, one of which was to introduce alternatively fuelled vehicles.

During 2001, the company needed to buy more tractor units, and it was decided to trial natural gas powered vehicles (CNG), one of which was a re-engineered diesel vehicle to run on natural gas. The trial demonstrated that both models would bring significant cost savings without any serious impact on operations. The re-engineered vehicle was subsequently chosen as the type to be purchased as it was deemed more environmentally friendly than a completely new vehicle has it was "recycled". However, the company were concerned about a lack of infrastructure, and considered investing in a refuelling point themselves. However, Lattice Energy Systems (LES), who were Transco's former partner company, had only just completed a CNG fast fill fuel installation located just off the M6 at Crewe, and once arrangements had been made for the Transco's vehicles to refuel at the LES station, 6 re-engineered tractor units were introduced to the fleet.

Following monitoring of these vehicles performance, a number of benefits were achieved including a lower cost fuel of approx £0.10 per mile, 42 tonnes of carbon dioxide avoided, a 98% reduction in particulates and 86% reduction in nitrogen oxide emissions. Additionally, there were reduced levels of noise associated with the vehicles (Freight Best Practice, 2003).

7.10 Hardstaff

The Hardstaff Group consists of Hardstaff Haulage, a leading provider of road transport services, Hardstaff Traffic Barrier Services who supply concrete safety barriers, Charnwood Truck Services and Portal Gas Services, which provides natural gas vehicle refuelling infrastructure. In addition to having a continuous regular investment program, the group have developed their own OIGI™ dual fuel (diesel and natural gas) technology that can be run on CNG, LNG or Biogas. The company point out that the use of biogas reduces engine noise, SOx (Oxides of Sulphur), particulate emissions and NOx emissions and the technologies can be adapted to passenger cars, light and heavy good vehicles, buses and coaches, refuse vehicles and locomotives.

Hardstaff Haulage operates a fleet of approximately 160 heavy goods vehicles including tipper trucks, trucks mixers, articulated trucks, rigid trucks, low loaders and liquefied natural gas road tankers and as of 2008, 86 vehicles (approximately 50% of the fleet) were run on natural gas. Compared to diesel equivalents, the use of such vehicles had resulted in an 80% reduction in the amount of diesel used, a reduction in CO_2 of 20% and NO_X of 35-65% (Hardstaff Group, 2008).

To operate such a fleet of natural gas powered vehicles, Hardstaff needs a good network of natural gas refuelling stations, which in mid 2006 was not available. As a result of this, the group applied for funding from the Energy Savings Trust's Infrastructure Grants program to develop their own refuelling point at Newbold Quarry, Burton on Trent in Staffordshire (identified as Kingston in figure 5.1), which was successful and the new station is now operational (Energy Savings Trust, 2006). The station is able to be used by third party operators and can refill 50 vehicles per a day, and is able to operate for 24 hours a day, with 2 LNG dispensers and one CNG dispenser. As a result of the dispensers being pump fed, the refueling times are comparable with diesel systems (Portal Gas, 2006).

Furthermore it was announced in 2008, that Hardstaff would be benefitting from a bio-methane gas to liquid project operated at the Sita Albury landfill site in Surrey. The project between Gasrec and Sita will see the landfill gas collected, the impurities removed before methane is separated and liquefied to create LBM. The process claims to be able to recover 85% of the methane from landfill gas, and Gasrec has signed an agreement with the Hardstaff Group, to manage transport logistics and fuel transportation from Albury. The haulage trucks use Hardstaff's dual fuel system (natural gas and diesel), running entirely on LBM (NGVA, 2008).

7.11 Summary

As shown from the consultation, there are opportunities for private sector companies to utilise low emission and alternatively fuelled vehicles (see table 7.2). There are a large number of trials and demonstrations that are currently occurring such as the example of DHL and TNT with the Mitsubishi Fuso Canter Eco-Hybrid to demonstrate the business case of lower fuel costs compared to a larger upfront capital cost. Furthermore, the trialling and usage of such vehicles can feature in the corporate social responsibility of companies providing good publicity opportunities.

However, as demonstrated by Sainsburys and Wincanton, for companies whose vehicles have to travel the length and breath of the country, and beyond in some cases, there needs to be the scalability factor, where in some cases the range of vehicle is just not sufficient for trunking operations such as with all electric vehicles . In support of this are the situations with Transco and Hardstaff, who were only confident enough to utilise natural gas powered vehicles once there was sufficient infrastructure in place to allow re-fuelling to occur.

7.12 Trade Organisation Experiences

The concerns about economic viability, costs and benefits of the vehicles are echoed by the Road Haulage Association, who were consulted about this topic. As they point out, transparency and life cycle assessment is crucial, "for example, if the electric power comes from coal fired sources, the footprint could actually be worse" than their diesel equivalent. The RHA comments further that there are industry concerns about choice available, incentives, payload and reliability.

With regards to furthering usage of vehicles meeting the EEV standard and/or are alternatively fuelled, the RHA commented “there needs to be a uniform standard for Europe or the UK or at the very least, the *whole* of London, although this would be the least favourable option as, added to LEZ, Congestion Charge, and FORS this is creating an isolated commercial environment that may not be beneficial in the long-term. This point does link into the issue of scalability that was raised in the case of Sainsburys and Wincanton.

The range of vehicles that meet EEV standards and/or are alternatively fuelled which are available is limited as the selection in section 5 shows, and the issue of reliability, as identified in the experiences of the Boroughs who have trialled some of the vehicles previously, speaks for itself.

Table 7.2: Summary of Private Sector Experience

Company	Business Sector	Type of Fuel						Retrofit Systems	On Trial or Operational	Lessons Learnt
		Electric	Electric/Diesel Hybrid	CNG	Biogas	Biodiesel	Hydrogen			
DHL	Transportation and Courier	Yes	Yes	-	-	100% in 2 HGVs	-	-	On Trial	Fuel Consumption, Maintenance and Repair costs increased, carbon emissions decreased
TNT	Transportation and Courier	Yes	Yes	-	-	-	-	-	On Trial and Operational	Savings from congestion charge of £1750, cheaper refuelling costs compared to diesel
Wincanton and Sainsburys	Supermarket Supply Chain	-	-	Yes Dual Fuel	-	5%	Yes Dual Fuel	-	Operation bio-diesel, trial dual fuel vehicles	Biodiesel usage has lead to an increase in the number of fuel filter changes, and bacteria being present in the fuel system. Vehicles need to be scalable and can be implemented across the network.
Sainsburys Home Delivery Fleet	Home Delivery Service	Yes	-	-	Yes	-	-	-	Operational electric, biogas trial	Low levels of noise, high level of driver acceptance.
Tesco Home Delivery Fleet	Home Delivery Service	Yes	Yes	-	-	-	-	Connaught	Operational electric, retro system on trial	-
John Lewis Partnership	Supermarket Supply Chain	-	Yes	-	-	5%, 94% Pure Plant Oil	-	-	On Trial electric hybrid and 94% PPO, 5% operational	PPO trial has not had any affect on fuel consumption, loss in performance or effect on engine life
PF Whitehead	Transport and Logistics	-	-	-	-	-	-	-	-	N/A
Transco	Logistics Supplier	-	-	Yes	-	-	-	Yes	Operational	Significant cost savings achieved without serious impact on operations. Lower cost of fuel by £0.10 per mile.
Hardstaff	Logistics and Road Transport Services	-	-	Yes	Yes	-	-	Clean Air Power	Operational	-

8 CONCLUSIONS AND RECOMMENDATIONS

The information about vehicle registrations in the South London area, combined with data collected for other recent studies suggests that freight distribution within the area can be characterised as follows:

- Where trunking activities take place in the SLFQP area they tend to use HGVs, which are in the majority registered outside London and used on distribution activities throughout the UK, not just in London.
- Local distribution tends to occur using vans and HGVs less than 17 Tonnes GVW. A higher proportion of the lower weight vehicles tend to be registered in the London area, as they tend to be used on shorter, more localised and focused distribution activities for efficiency reasons.

Because of this difference, influencing the smaller end of the freight vehicle pool is likely to have a more concentrated effect. This is particularly the case because the depots from which the smaller vehicles operate from and the length of each individual collection and delivery round, all lead to a greater focus on operation within the capital.

In terms of maximising impact, this is promising because the review of the available vehicle and fuel technologies suggests that considerably more options exist for smaller freight vehicles than at the larger end of the spectrum. The review also suggests that there is currently more activity in terms of existing trials for vehicles below 7.5 tonnes GVW than for larger vehicles.

The continual tightening of European vehicle emissions regulations has had and is clearly still having an ongoing impact on the development of both conventional and alternative vehicle and fuel technologies. This development is likely to continue into the future. In many ways it appears that the EEV standard may have served its purpose. Current emissions standards are much tighter than were applicable when the EEV was conceived and specification of forthcoming Euro V and Euro VI, which will be mandatory for all vehicle sizes rather than advisory / aspirational and only applicable to vehicles over 3.5 tonnes, will continue to focus manufacturers attempts towards continuing compliance.

Although the developments to date have largely impacted upon toxic emissions (CO, NOx, particulates, hydrocarbons etc), it is likely that future developments will increasingly focus on ways to reduce the impact of vehicle activity on global warming. This may result in a change away from internal combustion engines to the increasing use of alternative energy storage options in combination with electric drivetrains (hybrids – using a range of combustible fuels, battery electric, fuel cells etc), particularly for smaller vehicles in the urban environment and where operational characteristics allow. The first signs of this are now appearing – the key will be the rate of take up and the associated availability of reliable vehicles. This is an area where the jury still appears to reserve its decision, although the results of some of the more recent trials by some of the larger commercial distribution organisations appear positive.

For larger vehicles the use of hybrids seems appears to be the most likely step in the short term, together with, or as an alternative to, the use of alternatives such as natural gas and bio-methane.

The number of vehicles that are directly registered to, or even contracted to the SLFQP Boroughs comprises a relatively small proportion of the total both registered and active within the area. However, the nature of the Borough fleet operations means that in theory they should provide an ideal opportunity for testing emerging technologies. This used to be the case, and many of the SLFQP Boroughs have trialled clean vehicles in the past. However, activity in this area appears to have reduced in recent years, even though most of the Boroughs include aspirational environmental selection criteria. This change can be attributed to two factors in particular:

- The cleanest vehicles tend to cost more to purchase and operate than the conventional alternatives, if for no other reason than production volumes are small meaning that development costs are less well spread per vehicle, and local authority budgets have come under increasing pressure in recent years, meaning that the scope for such trials has diminished, especially as the available grant funding has also largely disappeared.
- Local authority services have increasingly become the subject of stringent service delivery targets, which mean that the risk associated with vehicle trials and a possible reduction in vehicle reliability has led to reluctance to become involved.

In contrast to this it is encouraging to note that in recent years there appears to have been an increased involvement in trials from the private sector, particularly from some national household names. From a financial perspective it is probably easier for these organisations to make the decision to become involved in a trial, although the decision to do so (and particularly and subsequent decision to progress beyond a trial) will be subject to strict commercial considerations.

Looking to the future it is evident that a clear policy steer towards the procurement and use of clean delivery vehicles, preferably accompanied by a financial stimulus, will be essential there is to be a move from limited trials to more widespread use of clean delivery vehicles.

There are clearly moves in this direction. The appointment of CENEX in 2008 as the delivery partner and programme manager for the low carbon vehicle public procurement programme (LCVPP) is a welcome step towards reinstatement of some form of support for the public sector in this area.

By providing suppliers with the opportunity to demonstrate the real-world performance of their low carbon technologies in high profile public sector fleets, and providing definite evidence of public sector demand, it is hoped that the programme should promote the introduction of new technology at a small-fleet level. The 10 public sector organisations whose fleets are taking part in the demonstration include Glasgow, Leeds, Liverpool and Newcastle City Council, TfL and Royal Mail (LTT, 2008).

Making the transition from single vehicle demonstrators to volume introduction is a well-recognised problem for the industry, particularly for smaller manufacturers, and the programme will help to overcome this barrier. This is an important theoretical step towards the most difficult operational market to influence, the small operator, who has limited opportunity to experiment or take risks with emerging technology. In relation to changing the delivery and servicing vehicle pool in South London, influencing small operators will be very important.

In parallel with this, the actions of large commercial organisations will also be important in terms of raising profile in the area. One such company looking to challenge vehicle manufacturers to produce lower carbon vehicles are the John Lewis Partnership. In Jan 2008 John Lewis Partnership launched an initiative to develop a range of environmentally friendly prototype trucks and vans. The firm issued invitations to manufacturers and technology companies to help it create low-CO_2 emission urban vans, rural vans, multi-use trucks, including trailers, and on-board refrigeration systems. These vehicles will then be put into real fleet usage to enable the Partnership and other fleet operators to better understand the carbon and life-cycle cost savings potential of new and emerging low carbon technologies. John Lewis will provide technical and operational support for the design and development stages, and evaluate designs from mid-2008 to late 2009, or early 2010. John Lewis are working on this venture with Cenex, who will oversee the independent testing of the vehicle designs, along with the consultancies Millbrook and Mira. The firm wants to trial the full range of available low-carbon technologies, from electric and hybrid-electric vehicles to hydrogen and fuel cells, along with high bio-content fuels from renewable sources, such as bio-methane from waste, and it is envisaged that the winners of the challenge will benefit from future vehicle purchasing programmes.

The European Parliament proposal that the operational lifetime costs of energy consumption, CO_2 emissions; and pollutant emissions should be included in public sector procurement criteria, which forms part of the draft directive of the on the “Promotion of clean and energy efficient road vehicles”, could have a major influence in this area, depending on how it was incorporated within national legislation.

Finally the operational requirements, the benefits associated with the use of such clean vehicles and fuels and best practice guidance on their use through real life case studies needs to be clearly demonstrated and made freely available to interested parties. This could form part of a wider initiative focusing on all types of vehicles, not just delivery vehicles.

ANNEX A: POLICY CONTEXT

The European context

The issue of low pollution vehicles has been driven by European Legislation since the original proposal "*70/220/EEC Measures to be taken against air pollution by emissions from motor vehicles*" was adopted on 20.03.70 as a necessary condition for obtaining vehicle type approval. .

This proposal has been amended many times and progressively tightened, and there are now various emissions limits in place for new vehicles for the emissions of Carbon Monoxide (**CO**), Hydrocarbons (**HC**), Non Methane Hydrocarbons (**NMHC**), Nitrous Oxides (**NO_x**), Particulate Matter (**PM**) and Smoke, which differ for passenger and light goods vehicles (LGVs <3.5tonnes) and heavy good vehicles (HGV>3.5tonnes), and by fuel type. Since the Euro 2 stage, EU regulations have introduced different emission limits for diesel and petrol vehicles, with diesels having more stringent CO standards but are allowed higher NO_x emissions. Petrol-powered vehicles are exempted from particulate matter standards through the Euro 4 stage, but vehicles with direct injection engines will be subject to a limit of 0.005 g/km for Euro 5 and Euro 6.

Currently, the Euro 4 emissions standard is in effect, with Euro 5 due to come into effect for all new cars by September 2009, having been introduced for goods vehciels greater than 3.5 tonnes gross vehicle weight in 2008.

<u>Emission standards for Light Goods Vehicles</u>

Emission standards for light commercial vehicles are given in grams per a kilometre, whereas for heavier goods vehicles over 3.5t, the standards are set according to engine power in g/kWh.

Table 1: EU Emissions Limits for Light Commercial Vehicles in g/km (Dieselnet, 2007)

Category	Tier	Date	CO	HC	HC+NOx	NOx	PM
Diesel							
N_1, Class I ≤1305 kg	Euro 1	1994.10	2.72	-	0.97	-	0.14
	Euro 2, IDI	1998.01	1.0	-	0.70	-	0.08
	Euro 2, DI	1998.01[a]	1.0	-	0.90	-	0.10
	Euro 3	2000.01	0.64	-	0.56	0.50	0.05
	Euro 4	2005.01	0.50	-	0.30	0.25	0.025
	Euro 5	2009.09[b]	0.50	-	0.23	0.18	0.005[e]
	Euro 6	2014.09	0.50	-	0.17	0.08	0.005[e]
N_1, Class II 1305-1760 kg	Euro 1	1994.10	5.17	-	1.40	-	0.19
	Euro 2, IDI	1998.01	1.25	-	1.0	-	0.12
	Euro 2, DI	1998.01[a]	1.25	-	1.30	-	0.14
	Euro 3	2001.01	0.80	-	0.72	0.65	0.07
	Euro 4	2006.01	0.63	-	0.39	0.33	0.04

Category	Tier	Date	CO	HC	HC+NOx	NOx	PM
	Euro 5	2010.09[c]	0.63	-	0.295	0.235	0.005[e]
	Euro 6	2015.09	0.63	-	0.195	0.105	0.005[e]
N_1, Class III >1760 kg	Euro 1	1994.10	6.90	-	1.70	-	0.25
	Euro 2, IDI	1998.01	1.5	-	1.20	-	0.17
	Euro 2, DI	1998.01[a]	1.5	-	1.60	-	0.20
	Euro 3	2001.01	0.95	-	0.86	0.78	0.10
	Euro 4	2006.01	0.74	-	0.46	0.39	0.06
	Euro 5	2010.09[c]	0.74	-	0.350	0.280	0.005[e]
	Euro 6	2015.09	0.74	-	0.215	0.125	0.005[e]
Petrol (Gasoline)							
N_1, Class I ≤1305 kg	Euro 1	1994.10	2.72	-	0.97	-	-
	Euro 2	1998.01	2.2	-	0.50	-	-
	Euro 3	2000.01	2.3	0.20	-	0.15	-
	Euro 4	2005.01	1.0	0.1	-	0.08	-
	Euro 5	2009.09[b]	1.0	0.10[f]	-	0.06	0.005[d,e]
	Euro 6	2014.09	1.0	0.10[f]	-	0.06	0.005[d,e]
N_1, Class II 1305-1760 kg	Euro 1	1994.10	5.17	-	1.40	-	-
	Euro 2	1998.01	4.0	-	0.65	-	-
	Euro 3	2001.01	4.17	0.25	-	0.18	-
	Euro 4	2006.01	1.81	0.13	-	0.10	-
	Euro 5	2010.09[c]	1.81	0.13[g]	-	0.075	0.005[d,e]
	Euro 6	2015.09	1.81	0.13[g]	-	0.075	0.005[d,e]
N_1, Class III >1760 kg	Euro 1	1994.10	6.90	-	1.70	-	-
	Euro 2	1998.01	5.0	-	0.80	-	-
	Euro 3	2001.01	5.22	0.29	-	0.21	-
	Euro 4	2006.01	2.27	0.16	-	0.11	-
	Euro 5	2010.09[c]	2.27	0.16[h]	-	0.082	0.005[d,e]
	Euro 6	2015.09	2.27	0.16[h]	-	0.082	0.005[d,e]

† For Euro 1/2 the Category N_1 reference mass classes were Class I ≤ 1250 kg, Class II 1250-1700 kg, Class III > 1700 kg.
a - until 1999.09.30 (after that date DI engines must meet the IDI limits)
b - 2011.01 for all models
c - 2012.01 for all models
d - applicable only to vehicles using DI engines
e - proposed to be changed to 0.003 g/km using the PMP measurement procedure
f - and NMHC = 0.068 g/km
g - and NMHC = 0.090 g/km
h - and NMHC = 0.108 g/km

Emission standards for Heavier Light Goods vehicles

The emissions standards regarding heavier light goods vehicles (vehicles that have a gross vehicle weight greater than 3.5t) originated in EU Directive 88/77/EEC, followed by a number of amendments, and was consolidated in 2005, by the Directive 05/55/EC. The emissions standards are shown in tables 2 and 3.

Since 2000 when the Euro 3 emissions standard was introduced, the earlier steady-state engine test ECE R-49 has been replaced by two cycles: the European Stationary Cycle (ESC) and the European Transient Cycle (ETC). Smoke opacity is measured on the European Load Response (ELR) test. These are used for the following engine types:

Compression ignition (diesel) engines:

Conventional Euro 3 Diesel engines are tested using the ESC/ELR test:

- Diesel engines that have been equipped with "advanced after treatment" and are EEV approved Diesel engines are tested using ESC/ELR + ETC
- Euro IV and later engines are tested using ESC/ELR + ETC

Table 2: EU Emission Standards for Heavy Duty Diesel Engines, g/kWh (smoke in m^{-1}) (Category N2) (Dieselnet, 2007)

Tier	Date	Test	CO	HC	NOx	PM	Smoke
Euro I	1992, < 85 kW	ECE R-49	4.5	1.1	8.0	0.612	
	1992, > 85 kW		4.5	1.1	8.0	0.36	
Euro II	1996.10		4.0	1.1	7.0	0.25	
	1998.10		4.0	1.1	7.0	0.15	
Euro III	*1999.10, EEVs only*	*ESC & ELR*	*1.5*	*0.25*	*2.0*	*0.02*	*0.15*
	2000.10	ESC & ELR	2.1	0.66	5.0	0.10 0.13[a]	0.8
Euro IV	2005.10		1.5	0.46	3.5	0.02	0.5
Euro V	2008.10		1.5	0.46	2.0	0.02	0.5
Euro VI†	2013.04[b]		1.5	0.13	0.4	0.01	

† Proposal (2007.12.21)
a - for engines of less than 0.75 dm^3 swept volume per cylinder and a rated power speed of more than 3000 min^{-1}
b - 2014.10 for all models

Table 3: Emission Standards for Diesel and Gas Engines, ETC Test, g/kWh (Dieselnet, 2007)

Tier	Date	Test	CO	NMHC	CH_4[a]	NOx	PM[b]
Euro III	*1999.10, EEVs only*	*ETC*	*3.0*	*0.40*	*0.65*	*2.0*	*0.02*
	2000.10	ETC	5.45	0.78	1.6	5.0	0.16 0.21[c]
Euro IV	2005.10		4.0	0.55	1.1	3.5	0.03
Euro V	2008.10		4.0	0.55	1.1	2.0	0.03
Euro VI†	2013.04[d]		4.0	0.16[e]	0.5	0.4	0.01

† Proposal (2007.12.21)
a - for gas engines only (Euro III-V: NG only; Euro VI: NG + LPG)
b - not applicable for gas fuelled engines at the Euro III-IV stages
c - for engines with swept volume per cylinder < 0.75 dm^3 and rated power speed > 3000 min^{-1}
d - 2014.10 for all models
e - THC for diesel engines

The Environmentally Enhanced Vehicle standard was introduced by the European Union in 1999 to promote the use of the best available environmental technology for sensitive environments, and initially was only available with gas engines, although now the standard applies to all engines. The levels of emissions are similar to those of the Euro 5 emissions limits, which for heavy duty vehicles was introduced in 2008 for new vehicles, except with stricter limits for hydrocarbons and smoke.

Policy

There have a large number of EU commitments regarding “clean vehicles”, with the 2001 White Paper on the European transport policy for 2010 [COM(2001) 370: "European Transport policy for 2010: time to decide"] noting the need for further measures to combat emissions from transport and stated that the Commission would encourage the development of a market for "clean vehicles". The mid-term review [COM (2006) 314: “Keep Europe moving – Sustainable mobility for our continent”] announced that the EU will stimulate environmentally friendly innovation by successive Euro norms and by the promotion of clean vehicles on the basis of public procurement.

Following from this the Green Paper on energy efficiency [COM(2005) 265: "Energy Efficiency or Doing More With Less"] proposed concrete actions, such as the public procurement of less polluting and more energy efficient vehicles in order to build up a market for these types of vehicles. The following Action Plan [COM (2006) 545: "Action Plan for Energy Efficiency: Realizing the Potential"] confirmed that the Commission will continue its efforts to develop markets for cleaner, smarter, safer and energy-efficient vehicles through public procurement.

In December 2005, the Commission produced a draft directive on the promotion of clean vehicles through public procurement on 21 December 2005 [COM(2005) 634], which would have entailed public authorities having to source 25% of heavy duty vehicles for public transport service to comply with the Environmentally Enhanced Vehicle Standard. However, in June 2006, the European Parliament Committee on the Environment, Public Health and Food Safety (ENVI) adopted a legislative Resolution, rejecting the proposed directive. It is commented by Sheridan (2008) that the Committee felt that the proposal lacked ambition and that the range of vehicles and the objectives needed to be wider.

In light of this, there is currently a draft bill for a new EU Directive [COM(2007) 817] on the “Promotion of clean and energy efficient road vehicles”, which was proposed in December 2007. Instead of focusing on a set quota of vehicles that public authorities have to purchase that meet EEV standards, the European Parliament are proposing that the operational lifetime costs of energy consumption, CO_2 emissions; and pollutant emissions as linked to the vehicle to be procured are set as award criteria, in addition to the vehicle price. These criteria would be effect:

- Procurement of road transport vehicles:
- By public authorities.
- By operators providing services under a contract with a public authority.
- Purchase of road transport vehicles for the provision of public passenger transport services under license, permit or authorisation granted by public authorities.

The drivers behind this new directive include:

- The promotion of the market introduction of clean and energy efficient vehicles and contribute thereby to energy efficiency in transport.
- To reduce fuel consumption
- To assist in combating climate change through the reduction of CO_2 emissions.
- To improving air quality by reducing pollutant emissions.

There is also a proposal being considered for a Fuel Quality Directive [COM(2007) 18] (Amendments to Directive 98/70/EC relating to the quality of petrol and diesel fuels) that would require that the average life-cycle emissions (carbon intensity) of fuels sold be reduced by 10 per cent by 2020 (HM Treasury, 2007). This would enable the EU to:

- Reflect on developments in fuel and engine technology;
- Help combat climate change by promoting the development of lower carbon fuels, including bio-fuels; and;
- Meet air-quality objectives set out in a 2005 Clean Air Strategy, by reducing emissions of sulphur and PAHs (Poly Aromatic Hydrocarbons) from diesel.

However, this bill is currently still under review.

<u>Climate Change</u>

The adoption of lower emission and alternatively fuelled vehicles can also play a part in combating the fight against climate change. It has been acknowledged that climate change is currently occurring, and that atmospheric concentration of carbon dioxide and other greenhouse gases is rising. In 2001, the EU Sustainable Development Strategy stressed that the EU should aim to reduce atmospheric GHG emissions after 2012 by an average of 1 % per year over 1990 levels up to 2020. Since then, different EU members have carried out additional model analyses and have outlined specific proposals for future national targets (EU, 2007[5]).

<u>The EU Renewable Energy Strategy and Bio-fuel Directive</u>

In 2007, the EU Renewable Energy Strategy was announced, which set the target for a 20% share of renewable energy sources in energy consumption by 2020 for the EU as a whole, with the 20% being achieved through individual national targets. Three sectors are implicated by renewable energy: electricity, heating and cooling and transport, with transport specifically having a target that requires renewable energy to account for 10% of the energy consumption in transport excluding petroleum products other than petrol and diesel.

This strategy also included the EU “Biofuels Directive” (Directive 2003/30/EC) requires Member States to set and achieve targets for increased biofuel use. From this, the UK’s Renewable Transport Fuel Obligation (RTFO) Programme places an obligation on fuel suppliers to ensure that a certain percentage of their aggregate sales is made up of biofuels. The effect of this is that from April 2008 up to 5% of all UK fuel sold on UK forecourts will come from a renewable source with a target to achieve this by 2010. Since the Gallagher Review of biofuel sustainability the

Government's intention is to consult on the proposal to delay the introduction of the requirement for biofuels to comprise 5% of road transport fuel from 2010/11 to 2013/14. The 5% by volume target represents the maximum biofuel content allowed by European Specifications to be sold on the forecourts as standard petrol or diesel. It is intended to deliver reductions in carbon dioxide emissions from the road transport sector of 2.6 - 3.0 million tonnes per annum (equivalent to carbon savings of 700,000 - 800,000 tonnes) by 2010, by encouraging the supply of renewable fuels. To ensure that bio-fuels are produced in a sustainable manner, the directive sets out environmental sustainability criteria to ensure that bio-fuels that are to count towards the European targets are sustainable and that they are not in conflict with our overall environmental goals (see section 3.2.2).

However, from a UK perspective it has been commented that, "as bio-fuels are the only renewable transport fuel option commercially available on a significant scale today, it is likely that this target would have to be met almost entirely through bio-fuels. In the future, there will be considerations towards alternatives such as electric and hydrogen vehicles, which are likely to be of greater significance in the longer term" (DBERR, 2008).

The National and Local contexts

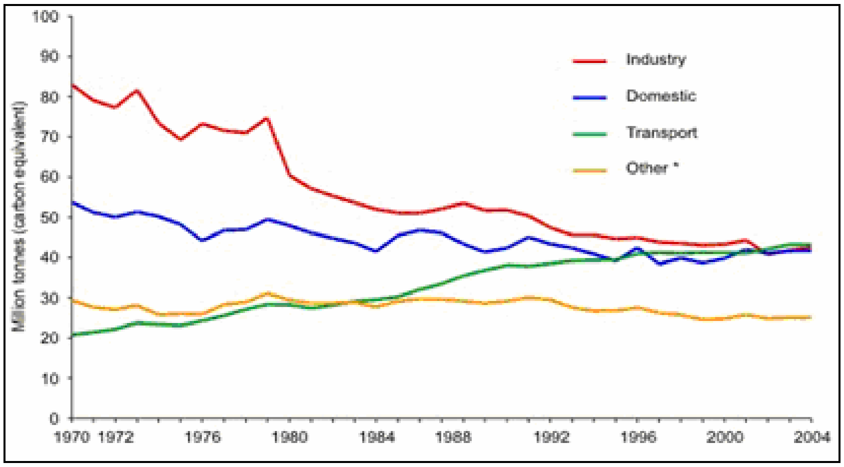
UK climate change policy

In the UK, the climate change policy is to reduce total carbon emissions by 60% of 1990 levels by 2050. This target has been commented as "a major challenge" and in the opinion of the King Review into Low Carbon Cars, will require almost total decarbonisation of the road transport sector. The review commented that:

"In the short term, whilst the internal combustion engine remains dominant, the scope for decarbonising fuels is likely to be largely determined by production of sustainable low-carbon bio-fuels as other low-carbon fuels cannot be widely used in the current vehicle stock. Given the significant land requirements of current bio-fuels, it is likely to be difficult to reduce the carbon intensity of fuels by more than 5-10 per cent over the next 10-15 years without risking significant land-use change. However, in the longer term, there is significant scope to decarbonise fuels through the use of electricity (batteries) and hydrogen (produced in a low-carbon way) as well as through bio-fuels with very low land requirements. By 2050, a "carbon-free" fuel mix is a possibility – although this is likely to be largely dependent on the degree to which electricity generation can be decarbonised and will also require significant developments in vehicle technology."

As of 2004, emissions from Industry and Domestic sectors have been reducing, but emissions from Transport have been steadily rising.

Figure 1: UK CO_2 emissions by end user, 1970-2004 (Defra, 2007)



In 2005, all of the UK transport, including aviation shipping based sales of aviation and marine fuels for international journeys departing from the UK accounted for 28% (46.2 million tonnes) of the UK carbon emissions. This figure is broken down in Figure 2. 70% of these transport emissions are associated with road transport. The road transport emissions are further broken down by vehicle type in figure 3, and shows that freight vehicles account for 38%, with light duty vehicles such as small commercial vans accounting for14% and heavy goods vehicles 24% (DfT, 2007).

Figure 2: UK transport carbon emissions in 2005 by sector

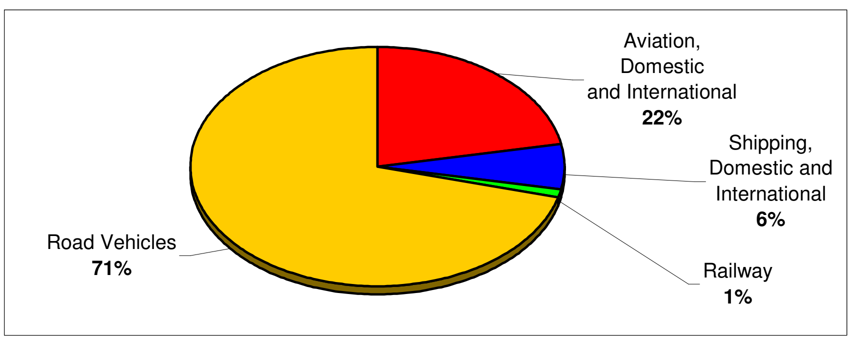
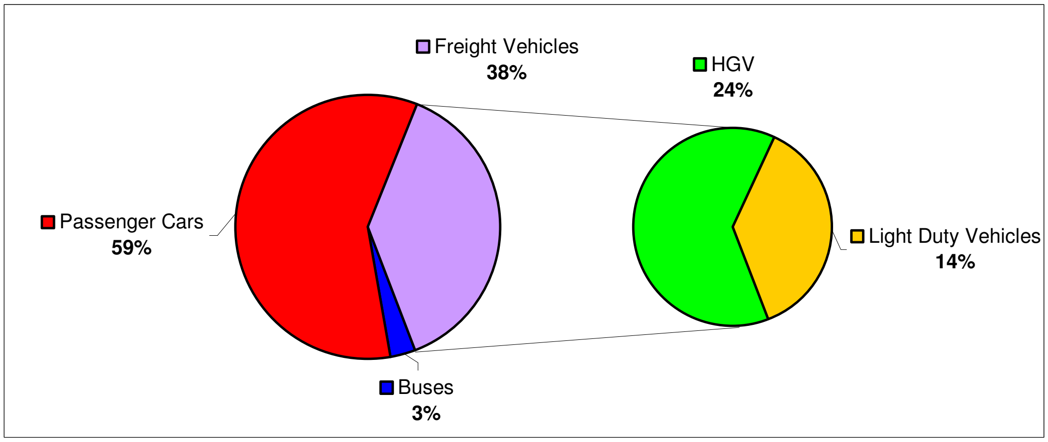


Figure 3: UK road emissions by type of vehicle in 2005



Research initiatives and demonstration programmes

Nationally, within the UK, the Technology Strategy Board which is funded by businesses and sponsored by the Department for Innovation, Universities and Skills, supports pre-commercial, industrial, collaborative R&D (CRD) and Knowledge Transfer Networks. In 2007, this, with further funding from DfT and Environment and Physical Sciences Research Council (EPSRC) launched the *Low Carbon Vehicle Innovation Platform (LCVIP)* which aims for to accelerate the market introduction of low-carbon road vehicles and is focused on bringing forward vehicle technologies that could be viable candidates for commercialisation or fleet procurement over the next 5-7 years (HM Treasury, 2007). The first call for proposals was launched in September 2007 and in May 2008 sixteen projects across a broad range of key technologies were awarded funding totaling £23 million.

The next stage of the Innovation Platform will see the Technology Strategy Board, DfT, EPSRC and Advantage West Midlands coordinate funding for a £70 million Low Carbon Vehicles Integrated Delivery Programme. This will manage low-carbon vehicle activity from initial research to procurement, speeding up the time it takes to get low-carbon vehicle technologies into the market place (DBERR, 2008 see section 8.1.3).

There are currently various demonstration and research programs that are underway including:

- The DTI Hydrogen, Fuel Cells and Carbon Abatement Technologies Demonstration Programme (HFCCAT), runs from 2007 – 2011 and provides grants with the aim of bringing forward the demonstration and deployment of low carbon energy and energy efficiency technologies. Of the total overall budget of £50m is expected that £35m will be allocated for Carbon Abatement Technologies and £15m for fuel cell and/or hydrogen technologies. (DEBRR, 2008[9]).
- The Foresight Vehicle programme is the UK's prime knowledge transfer network for the automotive industry and was designed to develop, demonstrate and exploit technology to stimulate the UK automotive supplier base to develop

products and systems which satisfy increasingly stringent environmental requirements while meeting mass expectations for safety, performance, cost and desirability. The programme, managed by the SMMT, is a partnership of vehicle builders and their suppliers, independent research consultancies and university departments, government departments and user representatives such as motoring organisations has generated over 100 individual projects, which have delivered a wide range of advances in manufacturing processes and product concepts, which are destined to shape tomorrow's vehicles as well as influence technological trends in transport systems and road networks of the future (SMMT, 2008).

The projects are organised within 5 project themes with HEAFV (Hybrid, Electric, Alternatively Fuelled Vehicles) most applicable in this case. Current projects under research include:

- City Hybrid-Electric Bus with Optimised Efficiency Using Information and Guidance Systems for Passenger Convenience and Vehicle Energy Consumption (CHOICE)
- Engine/Generator Sets for Hybrid/Electric Vehicles (EGHEV)
- Mild Hybrid HGV Powertrain (MIHPOW)

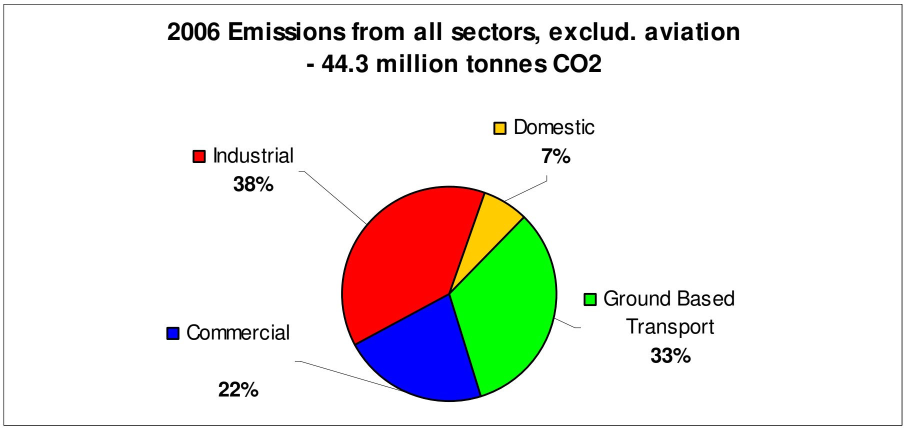
The Energy Technologies Institute (ETI) is a public/private partnership which selects, commissions, funds, manages and undertakes, where appropriate, the delivery of research programmes, with a significant proportion of funding focused on investment in a small number of key technology areas with the greatest promise for eventual deployment on the basis of their eventual contribution to low carbon, secure energy supplies. One of their objectives is to develop sustainable transport fuels and transport management technologies, although this area is not one of the programmes currently being carried out (ETI, 2008)

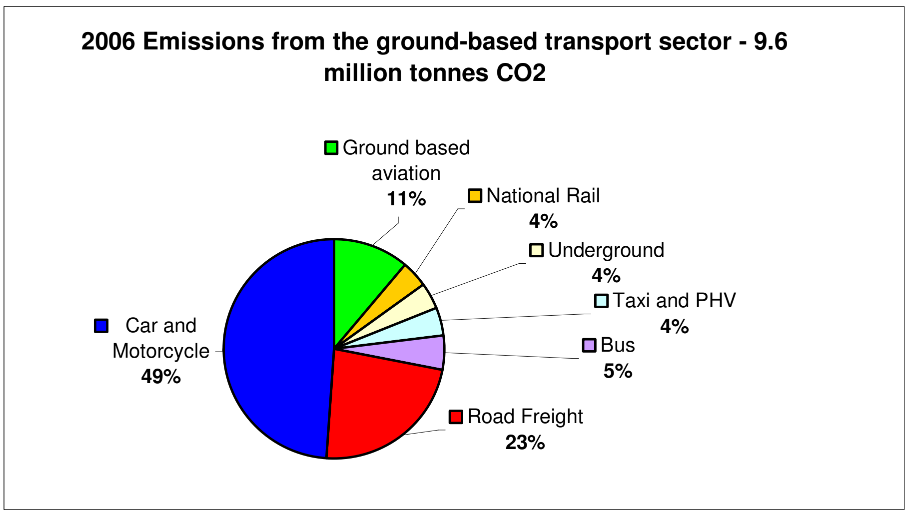
Support and funding for research and demonstration programmes is also available through Regional Initiatives and Research Councils.

<u>Locally in London</u>

In 2006, London was responsible for approximately 7% of the UK carbon dioxide emissions accounting for 44.3 million tonnes of CO_2 (mtC). This is predicted to increase as a result of growth in the economy and population by 15% to 51 million tonnes by 2025 unless action is taken. In 2006, ground based transport accounted for 22% of these emissions at 9.6mtC, with road freight accounting for 23%.

Figure 4: Carbon dioxide emissions from London and contributions to transport emissions, 2006 (Mayor of London, 2007[12])





In light of this, the previous Mayor of London, Ken Livingstone, in the Climate Change Strategy 2007 set the target for London to have reduced its carbon dioxide emissions by 16% of 1990 levels, by 2016 and as part of these targets, the strategy included the options of:

- Minimising emissions from travel, including procuring the lowest carbon fleet options wherever possible for both operational and support vehicles, reducing non-operational air travel to a minimum and off-setting essential travel.
- Following high green procurement standards for contracting all goods and services, and so stimulating market demand for zero and low carbon technologies, products and services. This measure should also help bring the price of the goods down as supply increases.

Air pollution in the city of London has health implications for the surrounding population of 7.4 million people, and particularly targets those that are most vulnerable – the very young and the elderly. As a result of this, and to achieve national and European air quality targets, it was stated in the Mayor's Air Quality Strategy that it would be necessary to accelerate the introduction of cleaner road vehicles and to take advantage of technological progress to reduce emissions of vehicles already on the road by:

In the short term:

- Targeting emissions reductions from the most polluting vehicles (mainly heavier diesel vehicles, such as buses, coaches, goods vehicles, waste vehicles, and taxis)
- Improving the take-up of newer, cleaner vehicles and technologies
- Improving the take-up of cleaner fuels

In the long term:

- Improving the take-up of zero emission. forms of transport (hydrogen fuel cell and electric vehicles)

To achieve these targets, the Air Quality Strategy proposed:

- Investigating the feasibility of introducing one or more low emission zones in London, which would prohibit the most polluting vehicles from specified areas
- Providing incentives for the purchase of cleaner road vehicles, for example, a 100 per cent discount for the very cleanest alternatively fuelled vehicles from central London congestion charging
- Leading by example, ie cleaning the fleets used by or on behalf of the GLA Group and setting out proposals for London boroughs, businesses and government agencies to do the same
- Using the Mayors planning and other powers to enable the expansion of refuelling infrastructure for alternative fuels
- Promoting the advantages of cleaner road vehicles and fuels (Mayor of London, 2002[13]).

In response to these strategies which support the introduction of low emission vehicles, 2 main policies have been launched in the London area.

<u>The London Congestion Charge</u>

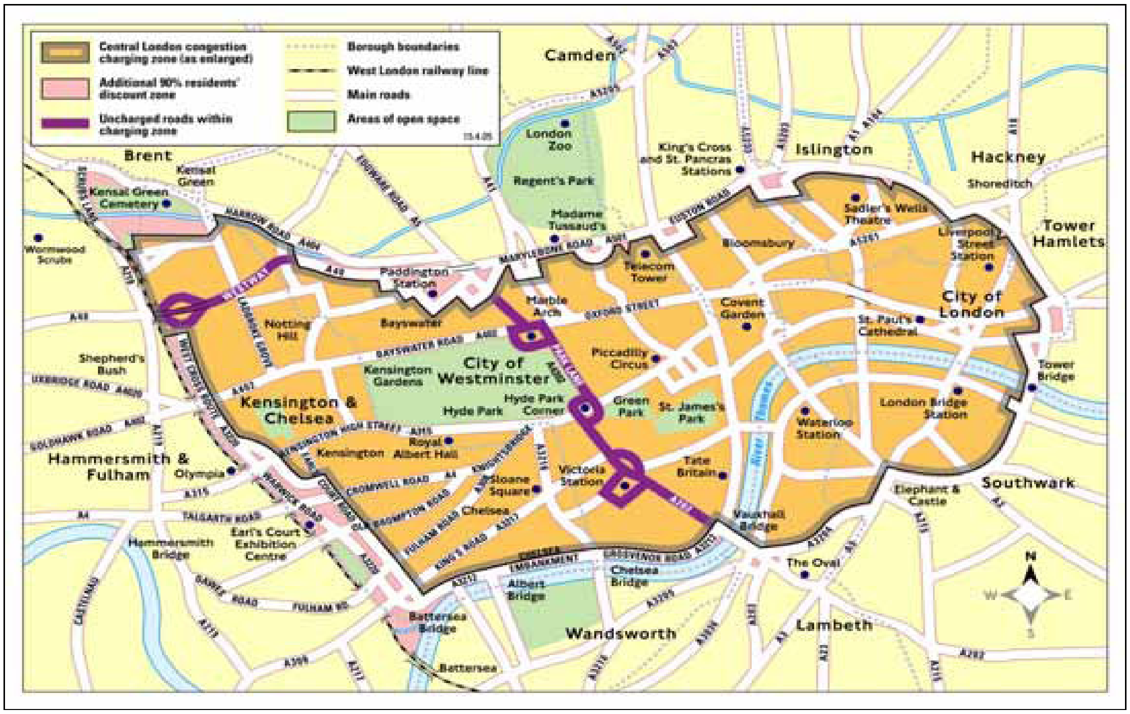
The London Congestion Charge was introduced in Central London in 2003 with the aims of:

- reducing congestion;
- making radical improvements to bus services;
- improving journey time reliability for car users;
- making the distribution of goods and services more efficient

The congestion charging zone originally encompassed a 22 square kilometre area of Central London, and was extended in 2007 westwards, now encompassing the majority of The City of Westminster, Chelsea and Kensington, part of the City of London and smaller parts of a number of other boroughs. However, it was announced in November 2008 that the Western Extension of the London Congestion

Charge Zone was to ill be scrapped, from 2010, following a period of consultation with local residents and businesses (BBC, 2008).

Figure 5: Map showing central London congestion charging zone (TfL, 2007[15]).



The congestion charge is applicable to all vehicles (except those with discounts and exemptions) entering the congestion zone between the hours of 07:00 and 18:00 Monday to Friday. The congestion charge costs £8 if paid on the day of travel, or £10 if the charge if paid on the first charging day after travel has been made. The following vehicles are 100% exempt from the paying the congestion charge:

- **Alternative fuelled** vehicles:
  - The vehicle must be powered by an alternative fuel, bi fuel or dual fuel, and not solely by petrol or diesel. It must also meet strict emissions criteria, which for Heavy Goods Vehicles (>3.5 tonnes) must meet the TransportEnergy Shift Power Register Band 2 Criteria which is equal to Euro 3 or cleaner for emissions of carbon monoxide, nitrous oxides, hydrocarbons, methane, particulate matter, and non methane hydrocarbons.
  - For Light Goods Vehicles, they need to meet the TransportEnergy Power Shift Register Band 4 Criteria, which must have oxides of nitrogen and hydrocarbons at least 40% cleaner than Euro 4 standards.

- **Electrically Propelled Vehicles** – the vehicle must be registered for with the DVLA and have a fuel type of "electric".

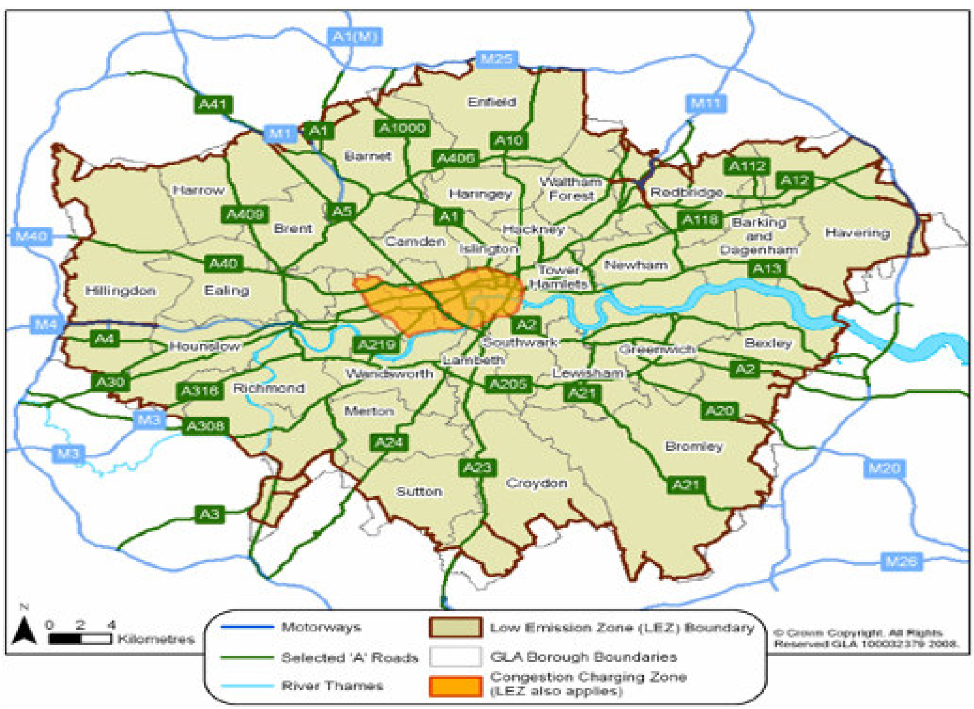
It was also recommended in the Proposed Emissions Related Congestion Charging Consultation document produced for Transport by London in 2008 that Heavy Goods

Vehicles meeting Euro 5 emissions standards should be incentivised, through a reduction in the amount they pay for the congestion charge. The proposed reduced rate would be £6 per day, £8 for next day £30 for five consecutive charging days, £120 for 20 consecutive charging days and £1,512 for 252 consecutive charging days. However, this would only be for vehicles that registered to received this, and it was originally proposed that HGVs would have been able to register from 06/10/08 with the discount due to expire on 01/10/08 in respect of HGVs, and 1st January 2012 for heavier vans, when the Euro 5 standard becomes mandatory for vehicles sold in Europe. In light of the findings of the consultation, it was recommended that the expiry period be extended for HGVs until 2010 with registrations starting on 27/10/08. However, this would only have been rolled out as part of the proposed £25 charge for the highest carbon emitting cars that the former Mayor of London Ken Livingstone intended to roll out had he been re-elected (TfL, 2008[16]).

London Low Emission Zone

The London Low Emission Zone was introduced on the 4th February 2008 to the Greater London Area and covers loosely bounded by the M25 (figure 6)

Figure 6 Map of the London low emission zone (TfL, 2008[17])



The low emission zone was introduced to combat air quality, and in particular towards reducing levels of particulate matter and oxides of nitrogen, in order to meet the EU air quality objectives for London by 2010. The zone is in operation 24 hours a day, 7 days a week and over time, different classes of vehicle have to meet more stringent emissions limits as shown in table 4.

Table 4: Class of vehicle, emissions standards and date of scheme implementation

Vehicle Type	European Vehicle Class	Date of Implementation	Vehicle Emission Standards to drive in the zone without charge.	Date New Vehicle Registration to assume compliance
Heavier HGVs (GVW> 12t)	N3	04.02.2008	Euro 3 for PM	01.10.2001
		03.01.2012	Euro 4 for PM	01.10.2006
Lighter HGVs (3.5<GVW<12t)	N2	07.07.2008	Euro 3 for PM	01.01.2002
		03.01.2012	Euro 4 for PM	01.10.2006
Buses and Coaches (with more than 8 seats and GVW>5t)	M3	07.07.2008	Euro 3 for PM	01.10.2001
		03. 01.2012	Euro 4 for PM	01.10.2006
Heavier LGVs (1.205<GVW<3.5)	N1 classes II and III	04. 10.2010	Euro 3 for PM	01.01.2002
Minibuses (more than 8 seats and GVW < 5t)	M2	04.10.2010	Euro 3 for PM	01.01.2002

If the vehicle does not meet the required emissions standards, there is a daily charge of £200 to enter the zone. When minibuses and heavier LGVs are affected by the zone in 2010, these will have a charge of £100 per a day if they do not comply with emissions standards.

However, it was announced in February 2009 that the extension of the LEZ to heavier LGVs and Minibuses, proposed for October 2010 was to be suspended on the grounds that it would have "a detrimental impact on businesses in the economic downturn." The extension would have affected 90,000 smaller vehicles (Guardian, 2009).

London Hydrogen Partnership

The London Hydrogen Partnership builds on the work of the EU's CUTE project, and developed a development plan in 2004 that envisaged 70 hydrogen powered vehicles being demonstrated in London. The project aimed to demonstrate both fuel cell technology, and hydrogen internal combustion engines, with TfL aiming to deliver 10 hydrogen powered buses, and 60 light vehicles encompassing motorcycles and scooters, passenger cars and vans. The 60 light vehicles were to be operated by TfL, the Metropolitan Police Force and the London Fire Brigade, and were to be rolled out with 20 initially, and then another 40. In addition, refuelling infrastructure was to be developed to in support, with procurement processes for the vehicles starting in 2006 (TfL, 2008[19]).

However, it was announced in Early August 2008 by Boris Johnson that London would not be going ahead with the purchase of the 60 light vehicles, following TfL's recommendation that they were not viable at this stage (BBC, 2008). However, Phase 1, with the roll out of 10 hydrogen powered buses, is still going ahead, with the purchasing agreements signed (Croydon Council, 2008).

Grant Funding

The Energy Saving Trust has previously provided funding through the Clean Up and Powershift programmes. The Clean Up Programme focussed on reducing the emissions of larger diesel vehicles over 3.5 tonnes either by converting their engines to run on alternative fuels or by fitting emissions reduction equipment such as particulate traps to the exhausts of diesel vehicles. Only the fitment of approved emissions reduction equipment and conversion systems was eligible for grant assistance, and only such equipment as recorded on the "Clean Up" Register was approved (Clean Air Power, 2007).

The TransportEnergy Powershift Programme provided direct financial support (through grants) to the procurement of new small vehicles (cars and vans) that were modified to run on cleaner fuels such as LPG, natural gas and electricity (including hybrids). The grants ranged from a few hundred pounds, to several thousands, and were calculated as a percentage of the additional expense of purchasing or converting a vehicle to run on clean fuels (Manchester On TRACK, 2003). This same principle is now in use with the Cenex-managed low carbon vehicle public procurement programme.

Both of these projects were discontinued in 2005. However, grants are still available towards refuelling infrastructure through the Refuelling and Infrastructure Programme (see section 5.3), and in 2007, there was a budget of £5 million per annum for the programme of supporting industry led low carbon vehicle R&D, as well as providing around £0.5m per annum of grants for the trialing and demonstration of infrastructure for alternative fuels, both of which are now managed by CENEX.

Fiscal Incentives

In addition to grants and funding for research, there are a number of fiscal and tax incentives used to promote low emission and alternatively fuelled vehicles:

- Road Vehicle Excise Duty is used to promote the purchase of more fuel efficient vehicles by increasing the cost of petrol and diesel
- Road Vehicle Excise Duty, which is levied annually, is graduated according to Carbon emissions.
- Company Car tax rules have been reformed to provide significant incentives to purchase lower CO_2 vehicles
- Bio-fuels (bio-ethanol and bio-diesel) enjoy preferential tax treatment relative to petrol and diesel, with a 20p/litre reduction in the duty levied until 2009/10

Renewable Transport Fuel Obligation

The use and uptake of bio-fuels has also been driven nationally by the Renewable Transport Fuel Obligation (RTFO) which was the UK's national response to the EU Biofuels directive. This was introduced in April 2008, and originally set a target for bio-fuels to make up 2.5% by volume of road transport fuel sales in the UK in 2008/9, increasing by 1.25% a year to 5% by 2010/11 (see section 4.3), although as explained in section 3.1.5, since the Gallagher Review of biofuel sustainability the Government's intention is to consult on the proposal to delay the introduction of the requirement for biofuels to comprise 5% of road transport fuel from 2010/11 to 2013/14.

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